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BRIEFLY TOLD.

PHOTOMETRY *vs.* CALORIMETRY.—Two men prominent in the gas business of the world, one a resident of St. Louis, Mo., U. S. A., the other a resident of Manchester, England, cannot fail of being particularly amused over the controversy now going on in gas circles as to whether photometry or calorimetry is to have precedence. The resident of St. Louis is Mr. B. E. Chollar, Chief Engineer of the Laclede Gas Company; the resident of Manchester is Mr. Thomas Newbigging. Each of these gas engineers, for such they undoubtedly are in the best acceptation of the term, declared well in advance of to-day that current gas engineering practice in some important respects was wrong. Mr. Chollar found fault with the practical outcome of the "Law of the Inverse Squares," and Mr. Newbigging thought and declared that a low candle power gas, in the eye of the photometrist, was a pretty good gas for all round use, provided its specific gravity was not too high. It looks now that Mr Chollar and Mr. Newbigging were right in their respective views, since the breath and words of to day are all towards perfection in gas through heat units rather than candle powers. So it looks that the current slogan must be, "Down with the photometer and up with the calorimeter." These "few lines" are inspired by an editorial article, in the *Journal of Gas Lighting* for the 13th inst., bearing the caption "Glasgow Decides for 'Light Gas.'" The lines of the article are, in substance: "It is with much satisfaction that we hail the resolution of the Corporation of Glasgow to apply for parliamentary powers to enable them, in the event of their finding the course expedient, to reduce the standard of the illuminating power of their gas from 20 to 16 candles. The Corporation Gas Committee and their Engineer (Mr. W. Foulis) are to be congratulated upon their public spirit and independence of judgment. Mr. Foulis, as all the world knows, is a pioneer in this line of industrial progress. Everybody does not know, however, although most of his professional colleagues can imagine how many and varied were the obstacles, overt and secret, to be overcome by Mr. Foulis in thus breaking with the tradition of Scottish gas manufacture. The cannel coal interest, naturally, was against him to a man. * * * Now the Gas Committee are experienced in the matter; and they know that the public will never notice any difference in the character of their gas supply, except that it will probably be cheaper. * * * What Glasgow and the rest of the world wants is coal gas of the calorific power of (say) 600 units per cubic foot. This, with no sulphuretted hydrogen, no ammonia, as little carbonic acid as may be, and not over 16 per cent. of carbonic oxide, is the article that the public would demand, if they knew what is best for them in this regard. How to make this gas and deliver it to the consumer at a good pressure, at the lowest possible cost, ought to be the chief study of gas works administrators and managers. This is the criterion which emerges from all that has been said and done these years past in the interest of the gas consuming public. Nothing but national fondness for red tape prevents the free development of the British gas industry along these truly economic and sanitary lines. Gas engines supplied with this gas would beat electric power, whether generated in bulk or in little, out of sight. It is what gas fires and gas cookers and water heaters need. They certainly do not want a continuance of the existing inequality of gas supplies in different towns.

And, of course, it is notorious what incandescent systems of gas lighting require for their fullest development. Marching already towards the future when the luminous flame burner will be the rare exception, the progress of the systems will make a bound forward when the superstition of carburetted gas is definitely shaken off. If the credit for the invention of the incandescent system of gas lighting cannot be claimed for Britain, we can at least excel all countries in the cheapness of its utilization. Let the people have the benefit of this happy feature of the British gas industry, by freeing the manufacture from every artificial restraint on its capacity for almost indefinite expansion!" Certainly this vent of the pent-up feelings of the *Journal of Gas Lighting* is a trifle hysterical, but the tone of the plaint is all one way. And that way seems to be in the direction of asking the gas men to adopt the illuminating standard which has prevailed with the electricians for some time. On the slow side, of course, such standard is; but if the high profit is to be made on the low service, then let us by all ways make the means commensurate with the end. Mr. Chollar and Mr. Newbigging are deserving of that comfort which successful pioneering brings, but we imagine that neither would, in common with the rest of their co-laborers in the gas field, be smiling so complacently were it not for the laborious studies, and the successful application of their outcome, by Dr. Carl Auer von Welsbach, whose work put the calorimeter on the pedestal formerly reserved for the photometer.

"Gas Lighting," by Mr. Charles Hunt.—Messrs. P. Blakiston's Son & Company, of Philadelphia, have favored us with a copy of their "Third Volume of Chemical Technology," which series was edited under the general direction of Charles Edward Groves, F.R.S., and William Thorp, B Sc. The prior volumes have been reviewed in the Journal, and a favorable criticism of both was made, for the merit of each was much. The current volume of the series, however, appeals especially to those engaged in the gas industry, and it is our satisfaction to say that its Editor (Mr. Charles Hunt, Manager of the Birmingham, England, Corporation Gas Works), went to greater lengths in his compiling than was done by any other writer on gas topics whose work is confined between the covers of a single volume. As a master in his calling, Mr. Hunt needs no recommending from us, for his management of the Birmingham hodge-podge gas committee has been and is of the sort calculated to cause one to think there is a trifle in municipal works' management after all. There, perhaps, the personal commendation should end, but, whether so or not, it is a fact that his presentation of the matter of gas lighting, in the Groves-Thorp series of Chemical Technology, is fairly and well abreast of the times in all the essential features of gas manufacture. It may not be thought a primer, but it certainly is a record, in which event both students and graduates can find profit and comfort in the perusing of its contents. The publishers, as is usual with them, have handled their part of the task well, as to printing, paper and binding, save that they might have omitted the bald bit of advertising done by them in binding a list of their medical publications within the volume's covers. The book numbers 312 pages, to the end of an excellent index, and the illustrations number 291. It is printed in two editions, of the "large octavo" sort; in cloth at $3.50; in half morocco, $4.50. The book is worth buying, from a gas man's point of view.

Notes.—The American Gas Company, through its Secretary, Mr. R. L. Babcock, informs the shareholders that a semi-annual dividend of 3 per cent. has been declared, payable December 1st.——The Lowell (Mass.) Gas Company has awarded a contract, to the Riter-Conley Manufacturing Company, of Pittsburg, Pa., for the erection of a storage holder calculated to retain 3,000,000 cubic feet. The holder is to rest in a steel tank, and it is to be completed on or before October 1st, 1901.——The American Bridge Company has been awarded a contract for furnishing over 700 tons of structural steel to go respectively to the New York Navy Yard, the Naval Powder Depot, near Dover, N. J., and to the Naval Magazine at Iona Island, N. Y.——Another contract for the Bridge Company is the new power station for the Grand Rapids Company, at Grand Rapids, Mich. The structure is to be 111 feet in width and 147 feet in length.——The proprietors of the New Bedford (Mass.) Gas and Edison Light Company will endeavor to secure permission to pipe the adjoining town of Fairhaven.——The authorities in charge of the municipal gas works at Duluth, Minn., through Manager Craig's sensible direction of their plant, have been enabled to announce a reduction in the gas rate to $1.25 per 1,000.——Advices just to hand convey the distressing information of the death of Mr. Herman Wilkiemeyer, Vice-President and General Manager of the Evansville (Ind.) Gas and Electric Light Company. His death occurred in Cincinnati, the evening of November 20th.

The Incandescent Gas Mantle and Its Uses.

[The second of a Series of Cantor Lectures, delivered before the Society of Arts, London, England, by Prof. Vivian B. Lewes.]

In the last lecture an attempt was made to trace the inception and growth of the incandescent mantle as it exists to-day, and it will be well now to tabulate the oxides which have been used in the manufacture of incandescent mantles, and see the amount of light emitted by each under the conditions existing in the mantles.

Light Emitted by Various Oxides.

Oxide.	Pure.	Commercial.
Metals.		
Zirconia	1.5	3.1
Thoria	0.5	6.0
Earth Metals.		
Cerite Earths—		
Ceria	0.4	0.9
Lanthana	—	6.0
Yttrite Earths—		
Yttria	—	5.2
Erbia	0.6	1.7
Common Earths—		
Chromium Oxide	0.4	0.4
Alumina	0.6	0.6
Alkaline Earth Metals.		
Baryta	3 3	3.3
Strontia	5.2	5.5
Magnesia	5.0	5.0

In utilizing these oxides for the manufacture of mantles it is evident that there are many points besides the power of emitting light which must be taken into consideration.

Some salts shrink so much during the conversion by burning into oxides that a mantle of very considerable initial size would have to be taken in order to get a skeleton of oxide of sufficient dimensions to fit the flame; other oxides which promise well as far as their shrinkage during formation goes, are found to slowly volatilize under the influence of the Bunsen flame, so that in the zone of most intense heating the thread of oxide gets thinner and thinner, and gradually disappears; other oxides, again, are brought too near to their point of fusion, and soften to such an extent that the mantle shrinks in where most heated and gets inside the zone of greatest heat, giving rise to a considerable loss of light, whilst other oxides, like yttria, give so distinctly colored a light as to be objectionable. Careful testing both as regards duration and strength leads one to the conclusion that of the oxides given thoria, zirconia, and alumina alone can be used for forming the structure of the mantle, but alumina has the drawback that the mantle is very hard and not easily shaped in the blowpipe, shrinks in the zone of greatest heat and slowly volatilizes, whilst zirconia mantles are liable to considerable and rapid shrinkage, so that thoria practically stands alone as the ideal basis for a mantle, as it is easily shaped in the blowpipe flame, gives a comparatively small shrinkage when the fabric containing the nitrate is being converted into oxide, and when formed the mantle resists the action of temperature for a longer period than any other known oxide.

Perhaps the most important property is the enormous increase which takes place when thorium nitrate is converted into oxide, as if a comparatively small mass of nitrate be heated on platinum foil, it swells up in much the same way that the sulphocyanide of mercury constituting the old "Pharoah's serpent" does, and the small bulk of nitrate becomes an enormously larger mass of thorium oxide, so that although in the mantles as now used there is 1 per cent. of ceria by weight, the proportion by volume is less than 0.1 per cent.

Having got the basis of thoria it is seen that in its pure condition it only emits about half a candle of light per cubic foot of gas consumed, but the difference between the lighting power of the pure thoria and the commercial at once indicates how sensitive it is to the exciting influence of small traces of impurities. When admixed with 1 to 2 per cent. of ceria it acquires a power of light emissivity combined with duration which is unequalled by any other known mixture of the available oxides.

Many attempts have been made to explain in a satisfactory manner the marvellous power which the minute trace of ceria has of awakening to life the light giving power of the mantle. In order that the mantle may emit its full measure of luminosity it has to be heated in the extreme fringe of the outer zone of the Bunsen flame, and here it is that the combinations take place between the products of incom-

plete combustion and the oxygen of the air. Such theories as attribute the power which the mantle has of emitting light to some special action that the ceria has in converting heat rays into light rays, which was the one put forward by Dr. Drossbach, are at the present time discarded in favor of the theory that both the air and gas are taking part in the actions which induce the luminosity.

Drs. Killing and Moschelles are of opinion that the ceria particles on the surface of the mantle are heated to a higher temperature than is the surrounding material, owing to cerium being a metal which forms two oxides, the lower, cerous oxide (Ce_2O_3), and the higher, ceric oxide (CeO_2), and that at a high temperature under the reducing action of the hydrogen and carbon monoxide, the ceric oxide becomes reduced to cerous oxide with the liberation of oxygen, which, combining on the surface of the ceria with the combustible gases in the burner, induces a far higher temperature in the ceria than exists in the thoria, and they suppose that the cerous oxide so formed under goes ovidation to the higher compound by the action of the excess of air present.

It is hard, however, to accept this theory in view of the extremely narrow range over which ceria acts as a useful excitant of the thoria basis, as one would expect that if the theory were a true one, the more ceria that was present the more particles would be heated to high incandescence, and increase in the quantity of ceria would increase rather than reduce the power of light emissivity.

The second theory and the one now most generally accepted is that propounded by Dr. Bunte, who ascribes the high illuminating effect produced by the trace of ceria as being due to a catalytic action of the same character as causes a piece of platinum foil, which has been heated in order to cleanse its surface, to become red hot when a current of mixed coal gas and air is allowed to impinge upon it, the action here being due to the power which platinum possesses of compressing both coal gas and air upon its surface, and rendering them so chemically active that they combine on the surface of the metal, and emit sufficient heat to raise the mass to a bright red.

Dr. Bunte made a number of experiments as to the influence of thoria and ceria in bringing about the combination of hydrogen and oxygen, and he found that at 1,200° Fahr. (649° C.), a mixture of hydrogen and oxygen, in the ratio of 2 to 1, when passed through a heated porcelain tube, combined to form water, and that the presence of thoria in the tube had no effect in lowering the temperature at which this action took place. When, however, the oxygen and hydrogen were passed through a tube containing ceria, the action commenced at 600° Fahr. (315.5° C.); and he concludes that this catalytic action, localizing a high temperature in the small particles of ceria spread over the surface of the large mass of inert thoria, is the cause of the high light emissivity.

Had Drossbach been right in ascribing the light of the mantle to any peculiar light emissivity on the part of the oxides, proof of this ought easily to have been obtained by the way in which rare oxides and mixtures behave when heated out of contact with air. Dr. Bunte found that in trying this experiment there was a very small difference in the noticeable light radiation from bodies of such widely different light emissivity as carbon, magnesia, thoria, or the mixtures used in the Welsbach mantle.

In order to prove this, Bunte took a thick walled tube of retort carbon, the walls of the middle portion of which were reduced to a thickness of 0.059 inch for a length of about 4 inches, and on passing a strong current of electricity through the retort carbon cylinder, the resistance of the thin walled portion caused it to be heated up to whiteness, the temperature attained being estimated by him at over 3,630° F. (1,999° C.). The tube was prevented from burning away at this highly heated point by being coated with magnesia, over which an outer wrapper of asbestos paper was pressed, and in the interior of this tube small square prisms of magnesia were placed, coated with the substances to be examined, each prism being compared side by side in the hottest portion of the tube. The conditions existing could be observed through a small sight hole at the end of the carbon tube.

By using double prisms, one of which was coated with the substance to be tested and the other with a standard substance of known composition, it was found that practically little or no difference existed between the various materials tested. This point was also confirmed by some very interesting experiments made by Mr. Swinton, in which he inclosed various mantle materials in a vacuum tube and submitted them to cathode rays, by which a very high temperature can be obtained, capable of raising finely divided carbon to incandescence and fusing platinum into glass. Using mantles made up of small squares of ceria and thoria alone and mixed in varying proportions, he found that, although the mixture of 99 per cent. thoria and 1 per cent. ceria in a vacuum heated up to incandescence more rapidly than pure thoria alone, and on stopping the discharge cooled down more rapidly, its incandescence was only very slightly greater than that of the thoria alone. Both these experiments clearly show that the idea of the Welsbach mantle having any peculiar power of converting the heat rays into light must be discarded, otherwise the same differences would have been noted when the materials were heated out of contact with air as when heated in the presence of air.

There are many facts which tend to support the theory that the light is due to the particles of the oxide of ceria being heated to a higher temperature than that of the flame. My own researches on the cause of the luminosity of flame point to the splitting up of the molecule of acetylene with the liberation of the endothermic heat contained in it as endowing the carbon particles with a temperature far above that which exists in the flame, so that the temperature of incandescence in the hydrocarbon flame is due to the heat of the combustion, plus the local endothermic heat of the decomposition, and in the same way in the mantle it is probably the heat of the flame which heats the whole of the mantle, plus the locally intensified points of excessive high temperature due to the catalytic action of the ceria upon the mixture of oxygen, carbon monoxide, and hydrogen, that gives the intense power of emissivity that the mantle possesses, the theory being made more probable by the fact that other substances known to have catalytic powers, when used in sufficiently small traces, give similar although not such marked results.

An objection to this theory may be raised from the fact that the amount of ceria is so minute that it does not seem possible that it should play any important part in the light giving power of the mantle. Dr. Bunte, however, overcomes this by pointing out that in an ordinary gas flame the luminosity is due to the liberated carbon particles being heated to an intense degree. This carbon is obtained chiefly from the decomposition of unsaturated hydrocarbons, which together only form about 5 per cent. of the volume of the gas. Supposing that all the carbon of the unsaturated hydrocarbons be liberated and heated to incandescence, it may be calculated that about 54 miligrams of carbon are separated from a liter of coal gas or 23.6 grains from 1 cubic foot. Thus 4 per cent. of ethylene and 1 per cent. of benzene give per liter of gas 60 cc. of carbon vapor from the benzene and 40 cc. from the ethylene, in all 100 cc., which is equal to about 54 milograms of carbon. The volume of the luminous portion of a flame having a consumption of 5.297 cubic feet per hour, and an illuminating power of 17.5 candles, is about 2 cc. at 32° F. (0° C.) It therefore contains $2 \times 54 \div 1{,}000$ mg or 0.1 mg (0.0015 grain) of incandescent carbon, and this small quantity of 0.0015 grain of incandescent carbon is sufficiant to yield a light of 17.5 candles. In a Welsbach mantle the amount of ceria is about 4 mg, 0.06 grain, or forty times the quantity of the incandescent carbon in an ordinary flame, and therefore this is quite sufficient to explain why the Welsbach mantle gives a light of 80 candles, when the argand burner only affords 16 candles.

The point that always seems a difficulty to me in this theory is that, if it be the true one, the only explanation of 1 per cent. of ceria being the amount that gives the maximum light emissivity, would be that in the outer envelope of the flame there was just sufficient unburnt combustible gas for this amount to act upon by its catalytic power, and that an increase of the combustible gas at this point should enable one to increase the amount of ceria present, but so far I know of no confirmation of this. Nor does the minute trace of ceria have the same exciting effect upon a zirconia or alumina basis. We have probably much more to learn as to the true action of the trace of ceria in exciting the light emissivity of the thoria mantle, and it must be borne in mind that thorium itself has some strange, and, at present, unexplained action towards light, which enables it to act in the same way as radium towards a sensitized plate in the dark.

The actions which lead to the emission of light in the "Sunlight" mantle are of the same character as those taking place in the thoria-ceria mantle. The basis is alumina, which itself has no power of emitting light, but is endowed with that power by the addition of chromic acid, which when itself made into a mantle is also void of any practical illuminating emissivity. Chromium, like cerium, forms two oxides, so that the theory of Killing and Moschelles would also apply to its light emitting power.

The light given by such a mantle is entirely dependent upon the proportion of the oxides of chromium present, and whilst with a small percentage only and using a dilute solution of alumina salt it is possible to obtain a nearly white light, increase in the strength of solution and percentages of chromium oxides gives a reddish yellow light.

It is impossible, however, in practice to use a solution for saturating the cottons sufficiently dilute to give anything approaching a white light, as if this is done, although the mantle will give a good light of about 14 to 15 candles per cubic foot of gas, the mantle shrinks so rapidly that in a comparatively short space of time it gets out of the zone of greatest intensity and only emits a very feeble light, whilst if the percentage of chromium is increased the light emitted is not so high, rarely exceeding 11 candles per cubic foot of gas, but the mantle lasts fairly well for three or four hundred hours.

Analysis of the "Pink Sunlight Mantles" show them to be composed of:

Alumina	86.88
Chromium oxides	8.68
Zirconia	4.44
	100.00

The zirconia being added to give greater strength to the mantle.

In these mantles the alumina, if used alone, would volatilize slowly at the heat of the Bunsen flame, so that in the zone of greatest intensity the threads rapidly would become thinner and thinner until finally they would disappear, this point being arrived at before the mantle has been in use 100 hours; the alumina, moreover, is near its fusion point, and is softened and rapidly shrinks. The oxides of chromium also slowly evaporate when continuously heated, so that the materials do not give much promise in making a good mantle, but when mixed together, or when the alumina mantle is sprayed with a dilute chromium solution, a far more stable compound is formed, of a pink color, and it probably dissociates slowly when heated for a long period, yielding a continuous supply of traces of oxides of chromium, which are the real source of the luminosity, and gradually burn off.

If, instead of an alumina basis, a pure thoria mantle be sprayed with the chromium solution, it becomes endowed with a certain degree of luminosity, but this rapidly falls away, there being nothing to prevent the volatilization of the chromium oxides.

The property which the chromium has of increasing the illuminating power, and prolonging the life of such basic bodies as it can unite with, is well shown in the case of the Fahnehjelm comb, which was originally made of magnesia rods, and lasted barely 100 hours, so rapidly did the magnesia volatilize; when, however, the idea arose of dipping the magnesia rods into a solution of chromic acid, it was found that not only was the power of emitting light nearly doubled, but that the life of the comb was increased threefold.

Many attempts have been made to improve upon or alter the composition of the 99 per cent. thoria and 1 per cent. ceria mantle by mixing such bodies as zirconia with the thoria, but it is nearly always found that any attempts in this direction tend to make the mantle far more susceptible to shrinkage, whilst if the foreign body so introduced is present in sufficient quantity to give any practical economy on the thoria saved, the light is at once affected.

Dr. Ernst Hintz, of Wiesbaden, whose researches on the composition of incandescent mantles and the influence of various factors on their light emiting power are, perhaps, the most complete ever made, found that quantities of neo-didymia, lanthana and yttria up to 2 per cent. have no influence on the light emitted by a mantle, the remainder of which consists of thoria and ceria at the ratio of 99 to 1, that 2 per cent. of zirconia just begins to affect the mantle, and that larger quantities of any of these bodies have a detrimental effect upon the light. His experiments and researches are of especial interest, as they show fairly conclusively the inception of the present mantle from the compositions mentioned in the 1886 or thoria patent.

The two minerals available for the preparation of thorium salts at the time of this patent, and, indeed, up to about 1892, were thorite and orangite. These are found in Norway, and are crude hydrated silicates of thorium containing from 50 to 72 per cent. of thoria together with traces of several other oxides of the rare metals, including ceria. From these the liquid for impregnating the mantles was made without any special precautions being taken to eliminate the traces of the other rare earths, the mantles made from this fluid being looked upon as consisting of pure thoria, whilst Dr. Hintz and others found that by employing the same methods of separation as were used for the manufacture the composition of the oxides made from the fluids obtained from these minerals are—

	Thorite.	Orangite.
Thoria	96.606	92.416
Ceria	0.994	3.162
Neodidymia and lanthana	1.205	3.227
Yttria	1.195	1.195

Compositions which agree very closely with analyses made of mantles sold in 1891-92, and which yielded an illuminating power of the same value as mantles made from liquids of this composition.

Monazite, which is the source from which the thoria now used is obtained, is mainly composed of phosphate of cerium and lanthanum, together with the phosphates of other rare earths, amongst which is thorium in quantities varying from a little over 1 to 16 per cent., and traces of many other bodies. This mineral, which used to be considered extremely rare, has now been found to be very widely distributed, its chief sources being the United States, Brazil, Siberia, Canada, etc., where it is found in the form of sand produced by the disintegration of primitive rocks.

Ceria being the main constituent of the monazite, and occurring in far larger proportion than the thoria, is separated with a much greater degree of completeness at the present time than was the case with the thoria made from orangite and thorite; indeed, it was only a few observers who, prior to 1890, had stated that thorite and orangite contained ceria.

Small as is the percentage of thoria in monazite, and laborious as is the separation of the thoria from it, the discovery of these large supplies of the mineral has reduced the price of thorium nitrate, according to Dr. Hintz, from £100 per kilo at the end of 1894 to the present price of about 30s. per kilo.

Of late years an important variation has been introduced in the manufacture of some mantles, in which, while the mixture of 99 per cent. thoria and 1 per cent ceria was employed, the principle under which the old Clamond basket was made has been pressed into service. As pointed out in the previous lecture, these baskets were made in the early eighties by weaving together filaments which had been formed by squeezing a paste of magnesia and magnesium acetate through a suitable orifice, and the woven mantle when baked could be rendered incandescent by means of an ordinary burner owing to the threads being reduced to a sufficient degree of fineness.

On November 4, 1890, Lungren took out a patent for an improvement in the method of manufacturing the mantle, which was a great advance on Clamond's original process. In this latter method it was found that it was a troublesome matter to get a coherent mantle owing to the threads at the points of intersection not welding properly, the first threads laid on the mould drying before the cross threads were put on, so that, when they were pressed together, the dried threads cut through the softer ones and did not properly unite with them. In order to overcome this, Lungren mixed his refractory earths into a paste with some combustible elastic material, and from this squeezed out the threads from which the mantle was woven, after which operation the elastic binding material was burnt out. As examples of suitable materials Lungren instances glue mixed with glycerine, india rubber dissolved in naphtha, etc., and states that a variety of materials may be used.

At the present day collodion is rapidly coming to the front as a vehicle for holding the incandescent oxides. This substance has a very interesting history. In 1838, Pelouze discovered that when paper was treated with the strongest nitric acid it was rendered exceedingly inflammable, and in 1845, Schonbein, the Swedish chemist, proposed the use of nitrated cotton-wool as a substitute for gunpowder, and showed that its combustion gave no smoke.

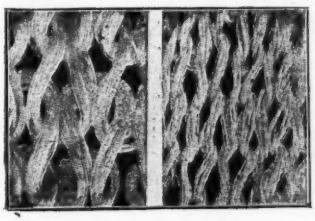
Several factories were soon at work making guncotton for explosive purposes, but several disastrous accidents taking place for which no apparent reason could be found, and guncotton being found unfitted for guns, the works were stopped, and it was not until late in the sixties that guncotton was made on a manufacturing scale as an explosive. Meanwhile, however, it had been found that if the strength of the nitric acid was not kept up a lower form of guncotton was produced, which was not of much use as an explosive, but which could be dissolved in a mixture of alcohol and ether, and that when these solvents had evaporated off a structureless, semi-transparent mass was left. Many commercial adaptations were soon found for this material, and its manufacture was started on a large scale.

Amongst the many other applications of collodion it has been employed for the manufacture of artificial silk, and large factories have been built in many parts of Europe for this purpose. In one process wood pulp is converted into collodion by nitration and this collodion is then dissolved in as little alcohol and ether as possible. In order to obtain the fiber the thick solution is forced by enormous hydraulic pressure through capillary glass tubes, the bore of which is less than the one-hundredth of a millimeter. Ten to twelve of the expressed fibers are twisted together and wound on to a bobbin, the air of the room being kept sufficiently heated to cause the drying of the filaments

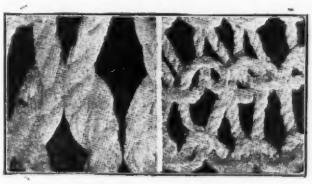
a few inches from the orifice of the tube. The compound thread is next denitrated in order to remove the extreme inflammability which it possesses at this stage, and for this purpose the skeins are dipped in a solution of ammonium sulphide by which they are converted into ordinary cellulose. The skeins are then washed and dried, the resulting product requiring an expert's experience to detect it from ordinary silk.

In 1894 De Mare utilized collodion for the manufacture of a mantle, adding the necessary salts to the collodion before squeezing it into thread. Following in his steps Knofler, in 1895, and later on Plaisetty took out patents for the manufacture of mantles by a similar process to De Mare's, the difference between the the two being that Knofler used ammonium sulphide for the denitration of his fabric, while Plaissetty employed calcium sulphide, the objection to which is the trace of lime left in the material.

Another method of the same kind for making artificial silk which has a considerable reputation is that known as the Lehner process, which in its broad outlines somewhat resembles the Chardonnet, but differs from it in that the excessively high pressure used in the earlier method is done away with by using a solution of a more liquid character, the thread being hardened by passing through certain organic solutions. It has been found that this form of silk lends itself perhaps better to the carrying of the salts forming the incandescent oxides than the previous so utions, and mantles made by this process, which we will peak of as Lehner mantles, show promise of being a most important development of De Mare's original idea.



Before Burning. After Burning.
Fig. 1.—Collodion Mantle.



Before Burning. After Burning.
Fig. 2.—Welsbach Mantle.

Mantles made by such methods as those of De Mare, Knofler, Plaissetty and Lehner, are clearly developments of the Clamond hood, and not of the Auer mantle. In the Clamond class the filaments are made by squeezing a homogeneous pastry material through small orifices so as to form rods or threads, and when the vehicle holding the salts is burnt off, the oxides are left in a thread of even density.

The Auer class consists of excessively minute filaments many hundreds of which go to form a thread, whilst each filmanent when burnt off after impregnation with the illuminating solution leaves a minute rod of the oxides having a dense central portion which was produced by the salts by capillary attraction being drawn into the small tubes in the center of the cotton fiber. This dense central portion is surrounded by a more or less spongy coating formed by the salts on the exterior of the fiber being reduced to oxides, and is kept in a broken-up condition by the escape through them of the gases from the burning fabric.

In the Welsbach mantles you have this enormous mass of small filamentary matter twisted in the thread into what after burning becomes practically a fluted column of oxides, whilst in the Clamond class of mantle you have each separate filament that forms the thread standing out separately by itself, so that what appears to the eye to be one solid filament, reveals itself under the microscope as a loose bundle of rods, which vary in number according to the make of the mantle, those made by the Lehner process having rather more of these separate filaments than those made by the Plaissetty and Knoefler methods.

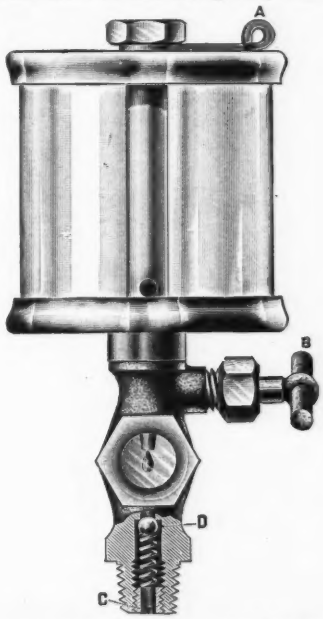
This alteration in physical structure has a most extraordinary effect upon the light giving life of the mantle, and also on its strength, as after burning for a few hundred hours the constant bombardment of the mantle by dust particles drawn up by the rush of air in the chimney causes the formation of silicates on the surface of the mantle owing to silica being present in the dust, and this seems to affect the Welsbach structure far more than it does the Clamond type, with the result that when burnt continuously the Welsbach mantle falls to so low a pitch of light emissivity after 500 to 600 hours as to be a mere shadow of its former self, giving not more than a third of its original light, whilst the Knofler mantle keeps up its light emitting power to a much greater extent, and the Lehner fabric is the most remarkable of all. Two Lehner mantles which have now been burning continuously in my laboratory for over 3,000 hours give at this moment a higher light emissivity than most of the Welsbachs do in their prime.

I am in hopes that I have been able to trace the causes which lead to this extraordinary result, and hope at an early date to be able to give the exact reasons that determine this phenomenon. In any case it may be stated that the trouble with regard to the length of useful light emission is practically solved, and that the new developments of the Clamond process form as important a step in the history of incandescent gas lighting as the discoveries which gave rise to the original mantles.

The Sargent Gas Engine Oiler.

The proper lubrication of the cylinder and piston of a gas or oil engine, in which the average temperature during inflammation is not far from 2,000° F., is one of the essential conditions of successful operation. In order to obtain the best results a constant feed, commensurate with the piston speed, is absolutely necessary, as too much oil will cause smoke and too little a cutting of the cylinder or piston. Then, with a variable speed, as in automobile engines, the amount of oil should be in proportion to the revolutions, and should stop when the engine stops, and to attain such results the feed must depend on some factor of the speed such as the induction strokes of the engine.

The illustration shows an oiler having many valuable features,



and it is being put upon the market by a prominent Detroit manufacturing concern. It was designed especially for lubricating the cylinders of gas or oil engines, vacuum pumps or air compressors, in which the pressure during the induction stroke is slightly below atmospheric pressure, which is almost always true of such machines, for if the pressure within were not less than without the cylinders would never fill. The essential features are a glass reservoir which is filled through a hole in the top, normally covered by the slide *A*; *B* is a needle valve

which adjusts the feed into the airtight bullseye, as shown; and *D* is a check valve, held to its seat by a spring, the compression of which is adjusted by the nut *C*, which can be turned with an ordinary screwdriver.

While this is essentially a cylinder oiler, by removing all compression from the spring it may be used in place of the ordinary sight feed oiler on any part of the engine.

When this oiler is used for admitting oil to the cylinder of a gas engine or air compressor the check valve spring is so adjusted that the valve seats when the air pressure above and below the check is the same, but if the air pressure below the check valve is rarefied or slightly reduced, the check will open and allow the air in the bullseye enclosure to pass into the cylinder, whereupon the atmospheric pressure on the oil in the reservoir will force it down through the needle valve to the bullseye chamber, from which it will pass into the cylinder every time the check valve opens.

When the engine stops, rarefaction in the cylinder ceases, the check valve remains seated and the oil stops feeding through the needle valve, because oil cannot drop into the bullseye chamber if air and oil are not drawn out.

When compression begins in the cylinder the check valve shuts and no smoke or pressure from the explosion passes into the bullseye chamber or reservoir. The reservoir can be filled while the engine is stopped or running without opening or closing a valve or changing the adjustment of feed. The quantity of oil is always in sight, and the amount feeding can always be seen; the oiler stops with the engine and begins when the engine is started again, and as no pressure accumulates in the glass reservoir there is no danger of the oil cup exploding.

This oiler is the invention of Mr. C. E. Sargent and is manufactured in several sizes by the Michigan Lubricator Company, 270 Beaubien street, Detroit, Michigan.

Exhaust Pipes for Condensing Engines.

Engineering Record says that it is somewhat surprising, at first sight, in view of the attention that has been paid to steam piping for high pressure power plants, that so little thought is frequently given to the design of exhaust piping. The reason for this is, however, quite obvious on reflection. Accidents to steam piping due to water hammer or to strains brought about by expansion and contraction, and the perhaps lesser troubles such as leakage at the joints, occur so often that engineers have paid much attention to steam piping, and have evolved a design which is becoming almost a standard, so far as general arrangement is concerned, and leaves little to be desired in the matter of safety and efficiency. Exhaust piping, on the other hand, is nearly always subjected to the pressures but little above that of the atmosphere, or even lower ones where an engine is connected to a condenser, so that the element of danger in exhaust piping is almost eliminated. Danger from water hammer in exhaust pipes hardly ever exists except in condensing plants, and then only when the piping contains a pocket in which water can lodge between the engine and condenser and thus be in a position from which it can be drawn into the cylinder in the event of loss of the vacuum. Even when such an accident does occur, the wreckage of the engine is about all the damage that can be done, and this is insignificant compared with the terrible calamities that have occurred when the failure of a high pressure steam pipe has allowed the steam from a boiler—sometimes batteries of boilers—to escape into the boiler or engine room with fatal results to the operatives there employed. Bad design in exhaust piping usually only affects the coal pile, and so few steam plant owners pay attention to the conditions under which their plants are operating that the effects of improper designs for such piping are seldom discovered.

The main points in which exhaust piping is faulty are in the use of pipes that are too small in diameter and too long in length, and in the use of too many elbows, all tending to increase the friction of the flow of steam and raise the back pressure against which the engine works. Defects of this kind are much more frequent and hurtful when engines are operated condensing. With a simple non-condensing engine working with about 40 pounds mean effective pressure, an increase in the back pressure of but 1 pound means a reduction in the power developed with the same cut-off of about 2.5 per cent. or an increase of not far from 2.5 per cent. in the steam consumed, if the cut-off is to be lengthened to allow the engine to work with the same load. In a compound condensing engine, the effect of increase in back pressure, or the reduction of vacuum, is far more costly, for the reason that the mean effective pressure is less. With a steam pressure of 120 pounds and a vacuum of 26 inches, the engine will operate most economically; that is with the least amount of steam per horse power, when the mean effective pressure referred to the low pressure cylinder is in the neighborhood of 20 pounds. If anyone will examine the indicator cards of many condensing engines and compare the back pressure in the cylinder with the vacuum in the condenser, as shown by a gauge, it will be seen that the loss in pressure due to friction between the engine and condenser often amounts to 1 or 2 pounds. With as low a mean effective pressure as 20 pounds, the increase of the back pressure by a pound means a considerable increase, theoretically about 7 per cent. in the steam used. The failure to obtain the benefit of the full vacuum in the condenser, or as close to it as possible, for, of course, there must be some loss between the engine and condenser, is far more detrimental to the economy of the engine than is the loss of a few pounds in the steam pressure as the steam passes from the boiler to the engine cylinder. Yet plants have been provided with larger separator receivers in the steam pipes close to an engine cylinder, so that the full boiler pressure could be utilized, whereas, at the exhaust end, where the loss in pressure is vastly more hurtful, the steam has been conveyed to the condenser through long pipes too small in diameter and containing numerous elbows. When under a vacuum of 26 inches of mercury, steam has a volume seven times what it has under atmospheric pressure, hence it can be appreciated how very much larger exhaust pipes of engines run with a condenser should be than if they were run without them.

One instance of thoughtlessness in the design of exhaust piping is perhaps worth noticing. The engine was fitted with a condenser and a feed water heater was placed between it and the feed water heater. To have the heater out of the way, and close to the feed pump, it was located in the boiler room, and the exhaust pipe, besides having all the elbows that were necessary to permit this arrangement, was provided with two more elbows so that the pipe could avoid a doorway. When the plant was started, the owner complained to the maker of the condenser that it was not large enough to maintain the vacuum that had been guaranteed. Upon investigation, it was found that while 26 inches of vacuum was maintained in the condenser, only 14 inches was realized in the engine cylinder, and that most of the loss was due to excessive friction in the exhaust piping. Although this may describe an exaggerated case, there are many plants operating under conditions far worse than they ought to be.

Persons in charge of condensing engines are frequently not aware of the true condition as to the back pressure in the cylinder, on account of the fact that the vacuum gauge is generally connected to the condenser, and thus does not show the fall in pressure between the engine cylinder and the condenser. Only by comparing an indicator card with the vacuum gauge can this be found.

Lucus a Non Lucendo.

"Inspector" in *The Metal Worker* says that no good comes of attempts to deceive the public by the systematic publication of misinformation on subjects which should be discussed truthfully or not at all. We are reminded of this by the industrious mendacity of certain ill advised advocates of acetylene gas, which is much too good a thing in its special sphere of usefulness to need such assistance in winning recognition. Take, for example, the following, which we find in a technical journal, apparently ambitious of recognition as the special organ of acetylene lighting:

Pure acetylene will not explode. It is only explosive like city gas when large quantities are mixed with a given volume of air and ignited. As acetylene burners use only one-tenth the amount that ordinary gas burners require, it follows that it will take ten times as long for a given volume of acetylene to escape if a burner is left open, and therefore the liability of accident is reduced to one tenth.

This statement is ingeniously misleading and may do a great deal of harm. Neither acetylene gas, coal gas nor water gas is explosive by itself. Indeed, it is not combustible without oxygen, which it gets only from admixture with air. It is a peculiarity of acetylene g s, however, that it becomes explosive when a great deal more diluted with air than either of the other gases with which it is compounded. Consequently, it has a very much wider range of explosibility than they have. With water gas, for example, the explosive mixture is from 7 or 8 to almost 20 parts of gas in 100 of air. With acetylene, however, we have an explosive mixture with anything between 3 and 30 parts of gas in 100 of air, experiments showing that its maximum explosive violence is

reached when present in air in proportions ranging from 5 to 25 parts in 100. When it exceeds 30 per cent. in admixture with air it is fiercely inflammable and highly incendiary, increasing in the intensity of its combustion as the gas percentage increases, provided, of course, atmospheric oxygen can get to it as it does to "pure acetylene" burning at a tip. In view of this fact it does not follow that because only one-tenth as much gas will escape from a ¼-foot burner as from a 5-foot burner, the liability to accident is reduced with acetylene to one tenth what it is with water gas. As explosive mixtures are formed where gas accumulates, and not throughout a building or apartment, there is really very little difference in the danger to be apprehended from the leakage of acetylene from an open ¼-foot burner or from water gas from an open 5-foot burner. To assume that it is safer than it is tends to make people less careful with acetylene than they should be, and whatever encourages carelessness is mischievous.

A gentleman whose name is well known to *The Metal Worker* readers, but who is not sufficiently proud of his exploit to care to be mentioned, lately learned something about acetylene which was both interesting and instructive. He had taken home a small quantity of calcium carbide in a bottle for experimental purposes, and thought it would entertain his family to have its usefulness explained by exoteric exemplification. Procuring a tin funnel from the kitchen he dropped a lump of carbide into his glass of water, turned the funnel over it and applied a match. A beautiful torch of luminous gas was the result, but in about 1½ seconds there was a cannon shot; the funnel went sailing among the globes of the chandelier, the tumbler turned flip flap, spilling the water, and the lump of carbide slowly dissolved itself into gas and slacked lime in the middle of his dining table, burning a square yard out of the table cloth and spoiling the mahogany under it. This demonstration paralyzed the children, scared his wife into a fit, sent the waitress galloping after a bucket of water to quench the conflagration and produced other phenomena not down on the programme.

His further experiments with acetylene generation in home-made apparatus were conducted in the middle of the back yard.

The fact is that all gases that will burn will explode with destructive violence when mixed with air in the proper proportions. Degrees of explosibility count for very little practically.

Experience with acetylene has shown that when generated in a good apparatus, stored in a tight water sealed holder and distributed through pipes which do not leak, it is as safe as any other gas. The user would do well, however, not to be misled by the statement that it is much safer than other gas, because of the large volume of air required to make a relatively small volume of acetylene explosive. If this statement is analyzed it will be found to mean something very different from what is commonly understood by it.

A New Incandescent Lamp Holder.

The London *Engineer* deseribes a new system of electric lighting by means of which the lamps can be placed in any desired location. While the method is of interest it is not so simple, neither has it the wide application of the electro-magnetic lamp so much used in this country. Our contemporary says:

Speaking generally, the system consists in employing surfaces under which positive and negative conductors, composed of a large number of fine wires, are interlaced, while being insulated from one another. Incandescent lamps with their terminals consisting of spikes are thrust into these surfaces, and the spikes, penetrating through to the conductors, allow current to pass to the filaments of the lamps. A glance at the accompanying illustrations will serve to make the method of use perfectly clear. The cuts show a part section and part plan of one of the lighting boards. They are only sketches, and do not pretend to be drawn to scale, but they show quite plainly the construction of the boards. On a base board are fastened strips of specially prepared vulcanized fiber placed on edge. These are about $\frac{1}{16}$ inch thick, and, as will be seen, vulcanized fiber pieces are fitted to alternate ends of the channels formed by the strip, the result being that a long zigzag of fiber is formed. This construction is easily understood from Fig. 2, which shows a plan of the board during construction. At the bottom of each channel, and along the spaces at each end which are to be occupied by the positive and negative main conductors, is laid sheet asbestos. The main conductors are laid on the top of the asbestos. They consist of a large number of fine copper wires bunched together, and offshoots are led from these down the channels marked positive and negative respectively. The bunching is so arranged that the cross section of the conductor is diminished by just the amount of wire which is taken down each channel. The result is that the main conductors gradually taper toward their ends in exact proportion to the amount of current likely to be taken from them. Fig. 2 shows part of the board in course of construction. When all the wires have been laid properly flat and fill up the channels from side to side, further strips of asbestos are placed over them and rammed down hard, the resulting construction being shown in cross section in Fig. 1. The whole board is then carefully dried and varnished with special india rubber solution, the surface being then covered with a sheet of gutta percha. Further, india rubber solution is then applied, and the surface composition then put on. This consists of powdered cork, special india rubber solution, and other ingredients, and it is pressed down, making a fine dark brown surface, which can be readily pieced. The resultant board is a network of positive and negative conductors, separated only by thin strips of insulating material, so that a lamp provided with spikes for terminals can hardly be pressed into the surface at any point without making a contact through itself between a positive and a negative conductor. If by any chance a lamp spike should, in being pushed into the board, encounter one of the upright division pieces, it is only necessary to move it $\frac{1}{16}$ inch or so, and the division piece is avoided and the lamp can be pushed home. By this means any point of a board can be illuminated by the simple expedient of sticking in a lamp.

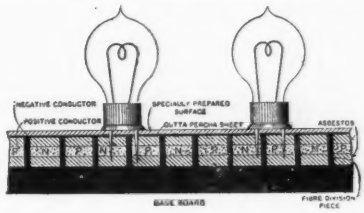


Fig. 1.—Section.

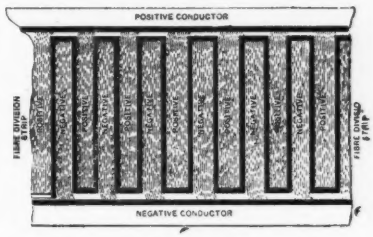


Fig. 2.—Plan.

It is easy to imagine a large number of applications in which this system may be employed. It will suffice in the present instance to mention a few of the adaptations exhibited to us by the company. First we had an opportunity of experimenting with one of these boards in the form of a table, and found that wherever a lamp was pressed into the table top, it was illuminated. There were also several designs of advertisement devices, where the form of the advertisement could be changed entirely by altering the positions of the lamps, words and designs being equally readily formed. Then there were shop showcases, in which an endless variety of combinations of lights could be obtained. In ordinary cases these alterations would entail a very considerable expenditure of time and money to bring about, for lamp holders would have to be wired and joints made. With the "lighting boards," however, there is no wiring necessary, and we are informed that the first cost is actually cheaper. For theater battens and effects the system is said to work excellently. Several battens were shown, one of which was movable, and stated t be considerably less in weight than an ordinary batten. A modification of the board was shown in strips where there are only two conductors, made up, however, exactly as the board already described. A number of examples of how these strips may be employed was exhibited. In any part of the length of these lamps can be stuck and light obtained, and our readers can well imagine to what number of uses such strips could be applied. One example alone of all those we saw need be quoted. It is suggested that a narrow panel consisting of one of these strips in a wood molding should run all around a room, and then light may be obtained in

any position by simply pushing in a lamp. In places where there is vibration or where the lamps are to hang globe downward, special clips provided with flanges are used, which grip the lamp caps and have their flanges turned into grooves at the edges of the strips. A further modification, specially adapted for temporary lighting and decoration, is by means of twin flexible cable and special clips. Examples of this form were shown to us, and the company hope soon to be able to put on the market this flexible cable with lamps so clipped on to it that the whole can be inserted in water.

So much for the system and its adaptation. Two questions naturally arose in connection with its use. They were these—how long would the surfaces last, and how does the insulation vary with use? We were informed as regards the first question that, taking a shop showcase where continual changes were always being made for an example, it was estimated that the surface would last for some two years, and would cost a very small sum for being renewed. The length of time would necessarily depend on the amount of use. As to insulation, we were told that the holes formed by the lamp spikes apparently closed up, and the insulation did not become appreciably reduced. For instance, a certain board with an insulation resistance between positive and negative of 8 megohms, and in which a lamp had been pressed 200 times in different places, had been exposed to the weather on a roof for months. At the end of this length of time the insulation resistance had remained unchanged. As regards the contact obtained, we were shown a board into which two staples had been driven and a 100 ampere fuse connected between them. The fuse had been blown, and there was no indication at the points where the staples had made contact with the conductors that any current had passed. There was no sign of sparking or fusing. We may mention that the carrying capacity of the conductors in the boards is calculated with reference to the largest number of lamps which can possibly be stuck into them.

New Legislation Affecting the Use and Misuse of Electricity.

Electrical World says that a very interesting and valuable report has been prepared by Mr. Samuel J. Barrows, Commissioner for the United States of the International Prison Commission on Crimes, Misdemeanors and Penalties in this country, as found embodied in the laws of the Fifty-fifth Congress, and the laws of the various States and Territories for 1897 and 1898. The object of this report is to show the spirit and tendency of modern legislation, and the various legal and ethical distinctions made in different parts of the country in the definition and punishment of crime. The most striking and interesting part of the report, to electricians, is that which deals with legislation bearing on the development of the electrical arts and industries. Mr. Barrows has contributed in his introductory report, a section which deals with this group, and his remarks on the subject are herewith submitted. It may be noted, however, and will naturally be understood that such new legislation has continued down to the present time. Just at present the courts are busy defining the rights and wrongs of automobilism.

When Benjamin Franklin raised his famous kite he was not conscious of raising new ethical or legal problems. His experiment was purely scientific. He meant to draw lightning from the clouds, and he succeeded. At the time there had not been enacted a law like that recently passed by the State of Connecticut, entitled "An act to prevent the stealing of electricity." That electricity might be guided, that it might be measured as easily as water, Franklin may possibly have foreseen. Did he imagine that it would be available for general consumption, that it could be stored as well as distributed, that millions of dollars would be spent in making and buying it, and that eventually electricity would become property?

Franklin's public reputation as an enterprising kite flyer is secure. Wholly different, however, would that reputation be to-day if, instead of flying his kite in the air and waiting for a thunderstorm, he should throw the string over a telephone, telegraph, electric light or electric power wire. If he escaped the physical consequences of contact with a wire carrying heat, light and power the legal consequences in most of the States would rapidly follow any such habitual experiment. In some cities he would come in contact with municipal ordinances forbidding him to fly kites at all in streets trellised with electric wires. The grounding of an electric wire means an "obstruction," or it means a diversion of the current involving an interruption of business or a loss of power. When telegraph wires were first put up in New York the kite nuisance was one of the most common interruptions, and, in crowded cities, a war had to be made upon kite flying. But electricity as property is exposed not merely to the hazards of weather and to ignorant interference; it is exposed also to theft. It is an easy thing for a skilled operator to tap a wire and steal a message. It is not difficult to divert the current to run a dynamo in your own cellar; and if a man has a grudge against a telephone or a telegraph company he may cut off its business with a pair of nippers.

It was inevitable, therefore, that electricity as property should seek insulation in the statutes of most of the States. Within the last two years a dozen States have had to modify their laws in order to punish "the stealing" of electricity, as it is called in Connecticut, or "larceny," as it is called in Montana, or "malicious obstruction, disturbance or diversion of the electric current," or "tampering with meters," or interfering with apparatus, which the law recognizes in various other States. It is generally agreed that electrical property must be protected, and all the session laws have become storage batteries for fulminating legal maledictions and contradiction; but the legal doctors do not agree as to what the punishment shall be, and it is here where the contradiction comes in, as it does in every attempt to scale penalties to crimes.

Connecticut, under a law passed in 1897, punishes the stealing of electricity by a fine not exceeding $50, or by imprisonment in the county jail, which may last 90 days. Montana punishes such "larceny" by a fine of from $100 to $500, equal to the penalty for the larceny of gas or water. In Michigan the penalty is $100 and costs, or imprisonment not exceeding three months, or both fine and imprisonment. Maryland, New Jersey and Iowa have the same penalties—a fine not exceeding $500, or imprisonment of not over six months, or both. Georgia makes the offense a misdemeanor, the punishment for which may be a fine of not more than $1,000, imprisonment not exceeding six months, or work on the chain gang twelve months. The same variation will be found in other States. Though there are meters for water, gas and electricity, there is no pœnometer by which to measure penalties. If such a meter could be invented and introduced into legislatures and courts of justice we might hope for some uniformity in gauging penalties for crime.

Granted that Franklin may have foreseen that it would be a sin to steal electricity, could he have foreseen that it would be a sin punishable by fine or imprisonment to give it away? Yet the people of Nebraska have lately passed a law in which the giving away of electricity to certain persons is prohibited. Telephone and electric light companies are forbidden to give free or reduced rates to any city or village officials, and the officers or agents of a telephone company bestowing their favors in this way are liable to a fine of $100 to $500 and to imprisonment of from 30 days to 6 months. Electric light companies committing the same offense are liable to the same fine, and the guilty persons in such corporations may be imprisoned for from 30 to 90 days.

Why telephone officials should be imprisoned for 6 months and why electric light officials should get off with a maximum of 90 days does not appear in the statute. Passed in order to prevent unjust discriminations, a distinction is nevertheless made in the penalty where no difference is apparent. On the other hand, the penalty for the city official who accepts free or reduced telephone or electric light or water service is a fine of from $100 to $500 and imprisonment from 30 to 90 days, with forfeiture of office. The same penalty is provided for city officials accepting free passes on street railways. A laudable attempt has here been made to make the penalties uniform. The Nebraska law is an intimation that electric light, power and traction companies may become a source of bribery and corruption in municipal affairs, and that it may be even necessary to prohibit city officials from using water freely.

Thus the introduction of every new invention may enlarge the field of litigation. There is, first, an opportunity, unknown to the ancients, to quarrel about patents, which constitute a special law branch turning mainly upon questions of priority. That, however, relates to the birth of the invention; carrying it into court, but not into the legislature. The lawmakers are concerned, not with its genesis, but with its effect, and with the form of public injury into which it may be perverted. It is curiously interesting to note the way in which, sooner or later, new inventions are engraved in the criminal code. Not even the most utilitarian moralist would venture to suggest that there is anything wicked or maleficient in electricity or in any of the forces of nature. These are rather beneficent gifts for which we are grateful; but their application to modern life opens new sources of temptation or reveals new sources of danger.

A host of modern inventions or manufactured articles having a

market value constitute a new opportunity for the thief. Most of these articles come under the ordinary definitions and conceptions of property. They do not need to be catalogued in the statutes. The theft of a lamp is larceny; it may be a Roman lamp or a Greek lamp, an oil lamp or an electric lamp. Whether it constitutes grand larceny or petit larceny will in certain States of the Union depend, not upon its age or newness, but upon its market value. On the other hand, there are a great number of modern crimes which could not have been committed in ancient days because the instruments for their perpetration did not exist. They are the outcome of modern civilization and they require new legislation.

The tapping of a telegraph wire is a modern form of highway robbery. In the old days, the method was to waylay the courier on the road and to rob him of his purse or of his message. The formula of the modern highwayman is not, "Stand and deliver," but simply "Deliver." And he may get a message from the lightning courier which may be worth more to him than a well filled purse. But there is nothing to be gained by indiscriminate tapping. It is some special message or information that the thief is looking for, possibly for its effect on the stock market or on other business ventures; but the use of cipher codes renders the tapping of telegraph wires of little avail even in time of war, unless the code, as well as the message, has been stolen. For the tapping of power or light lines the modern highwayman comes in out of the rain. He can do his business better indoors by attacking the electric meter, confusing its calculations, and thus getting more current than he pays for. Such at least seems to be the implication of recent statutes.

If, however, electricity permits itself to be used as an agent of crime, it is also invoked to prevent crime. The housebreaker must beware of the burglar alarm, and the flooding of stores at night by electricity is a brilliant defiance to his dark lantern. The telephone and the telegraph may assist in capturing the criminal, and the electric light may illumine his cell and his intellect. The motive for introducing the electric light in the Kentucky penitentiary at Frankfort is thus declared in the statutes of 1898, "that inmates may have an opportunity to study at night."

In adopting execution by electricity Massachusetts followed in the wake of New York. It is more merciful than hanging, and more rapid. It can be done in a cell with a few witnesses, instead of with theatrical effect in the rotunda of the jail or in the jail yard with several hundred spectators. In civilized communities, if the death penalty persists, the electric current will no doubt displace the rope and the axe. But Colorado recently cut the hangman's knot in another fashion by abolishing capital punishment altogether.

In modern legislation steam has had an enormous influence, especially in the way of railroad legislation. The introduction of electric railways now renders necessary many verbal amendments in the laws of the States. Penalties have long been enacted for obstructing steam railroads. Where the word "steam" was used in the statutes the phrase "steam or electricity" is now necessary. So, in recent statutes, there will be found many laws for the protection of street railways and for punishing interference with electric motors, just as interference with locomotive engines is punished. Electricity has even made itself felt in the game laws, in many of the States the use of electric launches as well as steam launches being prohibited in duck shooting.

Some Data as to Central Station Costs.

Prof. W. D. Marks, President of the City Heat and Light Company, of Fostoria, O., in an open letter addressed to the City Council of that place, on the subject of municipal ownership, has this to say:

When I tell you that in the great and prosperous State of New York three-fourths of the electric lighting companies have never paid a dividend, when in addition to this I can assure you that the city of Toledo, with its marvelous increase of population, has never had in it an electric lighting company which has paid a dividend, you will begin to realize what has been most vividly borne in upon the writer, that is the fact that neither the capitalists nor the managers of most of the electric lighting companies now in operation, and which they assume to manage, have ever grasped the commercial conditions which should control the fixation of their prices. Had they done so, instead of the story of speculation, consolidation and constant loss to which I have referred, there would have perhaps been a somewhat less general spread of incandescent lighting in all directions, but, on the other hand, a greater specialized growth in directions for which it is pre-eminently adapted, and the investors in these enterprises would have received a fair profit, in the form of dividends upon moneys which may now practically be regarded as lost.

The disastrous history of municipal attempts at electric lighting also largely results from the facts already referred to, and the fact "that no man can serve two masters." The managing political body, if it consists of men desiring votes, will not adhere closely enough to the immutable financial conditions of the undertaking to bring about pecuniary success. The history of attempts of municipalities is about as follows: By means of a general tax levy on the whole community, sufficient funds are obtained to erect an electric lighting station. On the assumption that no profit need be made, the prices of electric light are fixed somewhat lower than those charged by neighboring private corporations furnishing electric light, regardless of the fact that the corporations may have found themselves unable to make money or expand their business. The works are started, and for the first year or two the bookkeper reports "a profit." What this bookkeeper means is that the amount of money received from consumers of electric light exceeds the amount of money paid for coal, lubricating oil, waste, lamps and the service of engineers, electricians, linemen and other attendants. The bookkeeper has overlooked the serious item of deterioration of plant and of interest on the money invested, so, after a few years, the municipality is asked for another appropriation for "extension of plant." Such a thing as deterioration is never mentioned, and all question of profit is waived. This maneuver is repeated once or twice, and then it begins to dawn upon the hitherto benighted brain of the taxpayers, using candles, oil or gas, that those using the electric lights are enjoying a luxury for which they (the taxpayers) are paying, and the works are sold at a loss, and the price of electricity rises. In the course of our oral interview you radically rejected all idea of a scale of charges based upon the expenditures of this company for its new works, and so I will not take the figures which might be drawn from the books, but make use of such figures as I have obtained from an experience of nearly a score of years in the operation and construction of electric lighting stations and machinery throughout the United States. In the case of economically but well built incandescent electric lighting stations, I have found that their cost ranges between $200 and $250 per horse power, when complete in all particulars and ready to run. We can take an average of $225 as covering the cost per horse power of charter, legal services, solicitors, real estate, buildings, boilers, pumps, injectors, steam piping, engines, belting, dynamos, measuring instruments, switchboards, lines of wire, poles, insulators, converters, underground conductors, meters, office furniture, taxes during erection, plans, drawings, salaries of engineers and experts, labor of men erecting lines, etc. After what I have told you of the ill success of capitalists and managers having their money invested in electric lighting and pretending to manage their business, it is not at all strange that others, who perhaps have never entered an electric station, should have formed views so erroneous as to render it almost impossible for them to understand the conditions upon which electric lights can be furnished at a profit, or, at least, without a sure ultimate loss.

I shall crave your closest possible attention while I next take up the actual figures of the cost of production of incandescent electric light. I have already told you that the average cost of electric stations per horse power is $225. A moment's reflection will convince you that the machinery and plant used for the production of electric lights are peculiarly subject to deterioration, and you will agree with me that placing the annual deterioration at 10 per cent. is a low rating since with the rapid progress of electrical science and machinery not worn out will have to be replaced within 10 years in order to keep abreast of the state of the art. You will thus see that the sum of $22.50 must be set apart each year for each horse power installed. In the case of this company, the fixed annual expense for office rent, taxes, salaries of clerks and managers, stationery, etc., amounts to $3,500. The number of lights attached is about 1,250, so, if we take $1,750 (one-half of $3,500) as the annual cost of supervision, of office expense, of reading meters, and of the thousand and one services which must be rendered our consumers, in our electrical department, each lamp costs for its care $1.40 a year. Theoretically, fifteen 16 candle power lamps should be operated to the horse power; practically 12 lamps to the horse power, after the losses are deducted, is nearly the actual fact; thus we have:

For annual depreciation.....	$22.50 per horse power.
For annual fixed expense.....	16.80 per horse power.
Total	$39.30

We have not yet taken up the question of profit on the investment, per horse power, nor the cost of the operations producing the electric

current. Dividing $39.30 by 365 days, and again by 12 lamps, we find that each lamp attached is costing the station $\frac{1}{10}$ of a cent per day while it only stands and waits in darkness to be used. We should, however, allow to the investors in electric lighting enterprises a fair profit on their investment (such as we allow to others in business) as their rights. If we can obtain money at 4 per cent. on bonds and mortgages, which have no risk whatever attendant upon them, we surely ought to allow to the average business man a profit of 8 per cent., and 8 per cent. of $225 is $18. Adding this to $39.30, and dividing the resulting $57.30 by 365 days and by 12 lamps, we obtain 1.3 cents as the price per day which should be paid for lamps which stand and await the consumer's convenience without being lit, provided the consumer is wise enough and generous enough to allow his neighbor, who serves him, an honest and moderate profit for his services.

Having led you to this point (as I hope, logically, and with your full concurrence) you will begin to wonder how any one can afford to do any incandescent lighting at all. It is right here that the saving condition allowing the existence of electric lighting enters in. The writer has found by experiments conducted on an enormous scale, using many thousand lamps attached at once, for a period of a year that it costs but $\frac{1}{10}\frac{6}{0}$ of a cent (about $\frac{1}{4}$ of a cent) to furnish the current to light a 16 candle power for one hour.

This is about the same as 3 cents per kilowatt hour for coal, lubricating oil, waste, lamps and service of engineers, oilers, firemen, linemen, inspectors, etc., required in manufacturing the electric current. To put this in another way, for 1 cent the current required to keep a 16-candle power electric lamp alight for 7 hours can be produced. It can be said, also, with commercial accuracy, that this 1 cent will keep two 8-candle power lamps alight for 7 hours, or four 4-candle power lamps alight for the same length of time. It is a remarkable fact that on the continent of Europe, where incandescent electric lighting has had the combined consideration of artisan and artist, the 8-candle power is the standard of illumination, producing the best and most artistic effect, when used in larger number, but not twice as often, as the 16-candle power lamp is used on this side of the Atlantic.

Perhaps it would be simpler to ask $1\frac{1}{10}\frac{1}{0}$ cents per lamp per day for all lamps put in, and merely reading the meter at stated intervals, to add for each lamp per hour $\frac{1}{10}\frac{6}{0}$ of a cent (about $\frac{1}{4}$ of a cent). Your reply to this, at once, is: "We do not use all of our lamps at once. We use only half of them, or a quarter of them, and consequently you are not obliged to invest $225 in machinery, plant, etc., every time we put in 12 lamps." My answer to this is: "Your statement is right, 51 weeks out of the 52 in the year, or perhaps even 364 days out of the 365 in the year." How about Christmas Eve?—how about the week before Christmas? Are not all lights burning then? We cannot store electricity as we do gas, and our machinery is not light or portable. It must be there the whole year, ready to meet your uttermost needs, and if you use it but 1 day in the year, our money must be invested the whole year. Again I must ask your most careful scrutiny of the tabulated results of my figures, which are subjoined. You will see that if electricity is used more than 3 hours it can be sold at a profit, and still be cheaper than gas at $1 per 1,000, and if it is used for 10 hours it can be sold at the same price as illuminating gas at 50 cents per 1,000, and leave a profit to the producer. I will say, for your information, that 200 lamp-hours of a 16-candle power lamp furnishes the same amount of illumination as 1,000 cubic feet of a 16-candle power gas. Beginning with $1\frac{1}{10}\frac{1}{0}$ cents, we have the following for 4 per cent. profit:

Tabulation.

Price for	1 hour	per day	.....	1.25	cents.
" "	2 hours	" "	.....	1.39	"
" "	3 "	" "	.....	1.53	"
" "	4 "	" "	.....	1.67	"
" "	6 "	" "	.....	1 81	"
" "	6 "	" "	.....	1.95	"
" "	7 "	" "	.....	2.09	"
" "	8 "	" "	.....	2.23	"
" "	9 "	" "	.....	2.37	"
" "	10 "	" "	.....	2.51	"
" "	11 "	" "	.....	2.65	"
" "	12 "	" "	.....	2.79	"

Price per hour	$1\frac{1}{2}$	cents	.....	per 16-candle	lamp.	
" " "	.69	cent.	.....	" "	"	
" " "	.51	"	.....	" "	"	
" " "	.42	"	.....	" "	"	
" " "	.36	"	.....	" "	"	
" " "	.32	"	.....	" "	"	
" " "	.29	"	.....	" "	"	
" " "	.28	"	.....	" "	"	
" " "	.26	"	.....	" "	"	
" " "	.25	"	.....	" "	"	
Price per hour	.24	cent.	.....	per 16-candle	lamp.	
" " "	.23	"	.....	" "	"	

Copy for Bookkeeper, Meter Rates.

1	hour	per day	.....	$1\frac{1}{2}$	cents per	L. H.
$1\frac{1}{2}$	hours	" "	.....	1.03	" "	"
$1\frac{1}{2}$	"	" "	.....	.88	cent "	"
$1\frac{1}{4}$	"	" "	.....	.77	" "	"
2	"	" "	.....	.69	" "	"
$2\frac{1}{4}$	"	" "	.....	.63	" "	"
$2\frac{1}{2}$	"	" "	.....	.58	" "	"
$2\frac{1}{2}$	"	" "	.....	.54	" "	"
3	"	" "	.....	.51	" "	"
$3\frac{1}{4}$	"	" "	.....	.48	" "	"
$3\frac{1}{2}$	"	" "	.....	.45	" "	"
$3\frac{1}{2}$	"	" "	.....	.43	" "	"
4	"	" "	.....	.42	" "	"
$4\frac{1}{2}$	"	" "	.....	.40	" "	"
$4\frac{1}{2}$	"	" "	.....	.39	" "	"
$4\frac{1}{2}$	"	" "	.....	.37	" "	"
5	"	" "	.....	.36	" "	"

The British Coal Trade.

The London *Economist* commenting on the position of the coal trade in England, says: There is a too ready disposition in some quarters to assume that coal is about to come down by the run. Our contemporary says: We can find no evidence in support of such an assumption, although undoubtedly coal is a good deal easier in all the chief centers within the last few weeks. There was certainly nothing in the proceedings of the annual conference of the Miners' Federation of Great Britain to warrant one in supposing that the colliers, at any rate, will do anything to help toward an abatement of the present great tax on the national industries. On the contrary, Mr. Pickard, the President, again boasted not only of having secured the establishment of "a minimum living wage" in the Midlands, but also of having got the maximum wage fixed for some time to come. The miners are living in a Fool's Paradise with regard to the minimum wage, as they will find when bad times come again, as bad times certainly will come, and before very long. The fixing of the maximum rate for a prolonged period, by agreement with the coal owners, is a matter of serious import to others than the colliers. As consumption declines, and it is already declining, the natural course of prices is downward. But the ability of coal owners to reduce prices to meet the lowering condition of industries will be limited by their wage contracts. Thus two things will happen. Those coal owners who cannot produce profitably at the prices to be obtained while wages are so high will have to shut down their pits. And the closing down of pits will imply not only the throwing of large numbers of miners out of employment, but also such restriction of output as to enable other coal owners to maintain a level of prices injurious to the general welfare of our industries. And from every part of the country, and of the world, we hear of shrinking trade, and of relaxation of industrial activity.

But as yet there is no abatement to speak of in the coal mining industry. The output has now overtaken the demand, no doubt, but has not yet overpassed it, except, perhaps, in one or two minor instances. The institution of the 8-hour day in Scotland has had a considerable effect on the output of that country, where till now every pit has had full employment, where relations between masters and men have been amicable for months, and where there have been no adverse incidents to interfere with the regular machinery of production. The plague has interfered with shipments from the West Coast ports, but not to such an extent as to affect operations in the collieries. Since the Lanarkshire miners, however, decided to work no more than 8 hours in any one day, they have sent less coal per man per week to the surface, though earning better wages than ever they have done continuously before. And this is a point to be noted in connection with the fixed policy of Mr. Pickard of the Miners' Federation to move heaven and earth and Parliament to get the Miners' Eight Hours Bill passed into law. He seems willing to support, and to instruct his followers to support, any Government that will promise to further this measure. Now, we do not object to any miners, or any man, wishing for as few hours per day as they are inclined to, provided they are content with a reward proportioned to their industry. But we entirely object to any man being compelled to cease work when he is able and willing to work longer. A legislative 8-hour day in the mines means a compulsory 8-hour day—a forcible restriction of the labor of adults able and willing to appraise their own capacity for work. And, perhaps, the general public never had a better oppor-

tunity than the present of judging how industrially disastrous such a policy would be.

The position at present is that while coal owners are still busily engaged, and collieries are almost everywhere fully employed in executing home and foreign orders, there is a very distinct and appreciable falling off in the demand. There is no longer that pressure for extra lots that enabled many coal masters and exuberant middlemen to exact famine prices from necessitous buyers in a hurry. The South Wales market is so greatly dependent on the export business that it is daily affected by the supply of tonnage. When arrivals of vessels to load are numerous, prices firm up, because then the output of the collieries can be got away against contracts. When arrivals are few, coal accumulates in the sidings, and concessions become the order of the day. There is, in fact, no great real depth or strength in the market. This, however, is usually a quiet portion of the year in the Cardiff trade, before the winter demand comes on, and as there has been a good deal of chartering of late it is probable that there will be some renewal of activity (though devoid of recent excitement) until the turn of the year. But there is very little contracting going on for 1901, the ideas of buyers and sellers being so far apart, and all those consumers who can do so are holding off in the expectation of lower prices. They are encouraged in this attitude by the vigorous efforts which the Americans are making to institute a regular business in coal with the Mediterranean and with the chief coaling ports. As an evidence of this, we hear that one great foreign shipping company, that usually contract in Cardiff at this season for a year's supply, to be delivered at their various stations, are just now contracting for only 3 months' supply.

Another evidence of a weakening market is that middlemen are now offering their holdings under coal owners' prices—perhaps even what they do not hold, but expect to buy cheaper later on. Broadly speaking, Welsh coal is now about 8s. down from top. Best Northumbrian is about 4s. down from the highest; but then, neither Northumbrian nor Scotch went so high as Welsh did both last winter and at the time of the Taff Vale strike. Scotland has been most moderate of all shipping centers, and Scotch coals are now from 1s. to 1s. 6d. down from the highest. But still prices all round are a good deal higher than they were in December last before the great "spurt," and fully 50 to 70 per cent. above the level of a year ago. Thus in October, 1899, best Cardiff was 13s. 6d., best Northumbrian 10s. 6d. and Scotch steam 10s.; whereas now the prices may be called 22s., 16s. 6d. and 15s. respectively.

The home consumption for industrial purposes is steadily declining, with abating activity in the iron and steel trades, and, of course, the consumption has also been affected by the stoppage of so many cotton mills. The export demand has very seriously fallen off as far as Europe, and especially the Mediterranean, is concerned, and in Cardiff this week it is reported that there is a distinct scarcity of orders for the moment; but there will probably be a renewed demand for steam coal in connection with the transport of the troops, etc., home from South Africa, and that will prevent the dearth of fresh foreign orders being felt acutely for a time. A very decided decrease in the requirements of foreigners for British coal next year is one of the most hopeful features of the situation, as far as our industrial consumers are concerned. We fear, however, that the first year of the new century will witness troubled times in the mining districts before relations between masters and men are readjusted to suit the altered economic conditions.

Illuminating Gas from Sewage Sludge.

By X. Y. Z., in *Jour. of Gas Lighting.*

Although not coming within the range of what are regarded as practical politics, this subject is one, akin to many others, from which, by careful and impartial consideration, much benefit may be derived. The first impression likely to be created at the bare suggestion, to an unscientific mind, is one of contempt and ridicule. This has also been true of many another suggestion which time has modified, and in many cases completely overcome. It cannot be readily forgotten that our forefathers treated with the utmost disdain the suggestion of coal carbonization. The apparently preposterous idea of distributing an inflammable fluid through pipes was one ridiculed alike by the press and public. Great alarm was evinced at the proposal to store gas in holders at various stations. It is therefore only reasonable to briefly pass in review the early history of coal gas lighting, when considering a new proposition relating to gas manufacturing generally.

The presence of large quantities of marsh gas existent in sewage matter has been realized for many years; but the utilization of the same, and more particularly in connection with gas works, is comparatively speaking new. At the outset it will be recognized that only exceptional circumstances can possibly justify the carbonization of such sewage material in a properly organized gas works. Unfortunately, exceptional circumstances are not so rare as might at first be conceived. As an illustration, it may be pointed out that difficulties with coal owners have arisen upon more than one occasion in the history of coal gas manufacture and distribution. Such contingencies as a waterway being blocked with ice, or railway traffic congested, thrown into confusion, and utterly demoralized by a fog of some days' duration, when stocks of coal are at a minimum, are emergencies liable to arise every winter in connection with some gas works undertakings.

It must be at once assumed that special apparatus for the carbonization of different material is necessary. Retort settings, however well constructed for coal, pure and simple, would require certain modifications to suit them for another and totally different class of raw material. Lower heats would of necessity be desirable for the proper distillation of material including quantities of oil; the latter having to be "cracked up" at the most suitable and uniform temperatures. Alterations, too, in the methods of the purification of the gas would have to be carefully adjusted. A few years ago the idea was suggested in the *Journal* columns that the Yeadon revolving retort was likely to be the best form for the perfect carbonization of sludge. This retort has not been a success for "high" heats, such as are used in coal gas manufacture, but would probably be useful for "low" ones; the working parts of the gear work being unlikely to be affected by the lower heat to which they would be subjected.

Respecting the objectionable nature of sewage sludge, it might be argued that this material has to be dealt with somewhere and somehow; and, therefore, if it is possible to cope with it once and for all by carbonization, the better for all parties concerned. Considerable objections would arise between two departments—such as the gas and the sanitary—if the material were carted to the gas works. The sanitary authorities might advantageously erect at their sewage works a retort bench and purification apparatus capable of dealing with the quantity of material for disposal, thereby performing the duplicate process of manufacturing gas and destroying the sludge. Such gas could then be purified and delivered through a meter, or any other method of measurement, into the gas mains. This arrangement would be in accordance with the views expressed in an "Editorial Note" last week, to the effect that it was undesirable to allow any such material to enter a gas works, as it would upset the carbonizing plant and alter all the existing methods of calculation as to results. The raising of the heat required for the retort settings by dust refuse may be disregarded. In some sewage and electric works steam is raised by this means, with the assistance of forced draught appliances to a greater or less degree. To what extent this arrangement is a success is doubtful. In any case, forced draught contrivances have not been applied to retort settings, except in rare instances. Certainly, no well designed setting, worth the name, has such an apparatus attached to it.

There is a serious aspect likely to arise from the side of the consumer, at the moment it was suspected that sewage sludge material was being used, there would undoubtedly be a "hue and cry" respecting the vileness and impurities emanating from the gas. This, of course, would be only the result of want of information on the subject, as the purification of any gas can be readily accomplished; it being only a chemical problem to decide the means. A diamond is only carbon; and marsh gas, from whatever source obtained, remains unaffected. In dealing with such a subject, the objectionable idea must be subordinated for the time being, except so far as it becomes injurious to health.

The practicability of obtaining illuminating gas from sewage sludge has been pointed out at intervals by correspondents. The latest published results forthcoming are from Mr. Edward A. Harman, M. Inst. C.E., the Gas Engineer of Huddersfield. In the *Journal* last week certain results were stated, and opinions held by him were published, which are worthy of close attention. Other results have been obtained at Chorley; and further experiments are in progress, as was also indicated last week. It is not surprising to find a praiseworthy desire on the part of gas engineers to recover the percentage of illuminating gas known to be present in sewage matter, and to apply it to economic use. Such a desire is the natural outcome of, and possibly one of the benefits to be derived from, the extortionate high prices demanded for coal. Times of stress and storm reveal certain weaknesses in the vessel, which the skilled mariner quietly makes notes of for use in fair

weather. Similarly, the unpleasant position the gas industry has been forced into by the combination of the coal owners, leads thoughful men to consider what resources can be relied upon and adopted to provide, in some measure at least, against distress. The development of carburetted water gas is only one aspect of the great question. The economical working, too, of these plants is dependent upon low prices prevailing for coke and oil. At the present time, these commodities are at maximum rates; thereby handicapping this method of manufacture considerably. The important argument for the manufacture of water gas now relies upon its rapidity and easy usage when required.

To-day, the calorific value of gas is of really greater importance than its illuminating property. According to the evidence of experts upon the subject, gas of low illuminating power, within certain limits, has a higher calorific value than that of better quality. To such an extent has this become realized, that few gas works of any size do not now daily make regular calorific tests contemporaneously with the photometrical ones. After all, the question becomes merely one of cost. If from inferior material illuminating gas can be produced capable of performing the duty required by coal gas, although possibly with slightly less efficiency, it is one which will commend itself to consumers.

The question of a combination of coal consumers to resist the greedy demands of the coal owners is one alluded to by Mr. Harman in his letter last week. He rightly says that such combination can take various forms. Therein lies the strength of the argument. One cannot confess to being in love with the idea of raising illuminating gas from sewage sludge. But in this connection, it may be remarked that every experimentalist is in danger of thinking too highly of his own pet scheme. Although the subject is likely to be an unpopular one, the principle of searching for some substitute for coal is one which commends itself to all gas engineers under the existing circumstances—circumstances which have paralyzed the efficiency and profit earning capacity of the undertakings placed under their control, and for which they are directly responsible.

The question of carbonizing sludge in inclined retorts is certainly open to criticism and doubt. Even coals of different qualities and size require the retorts set at different angles. It has frequently been pointed out that one reason why inclined retorts fail to discharge their contents automatically, is because the coal with which the retort is charged has an angle of repose differing from the residual coke after carbonization.

The evidence as yet in favor of the wholesale carbonization of sludge is absolutely inconclusive; nor, it will be admitted by the most sanguine, is it particularly favorable. The results obtainable by local tests on an admittedly small scale of a material noted for its variability of composition, do not warrant any immediate excitement upon the subject. At the same time, it will not be forgotten that history has repeatedly proved that small beginnings have frequently big endings; so, in all justice to those gentlemen who have gone to considerable trouble experimenting with the material, the subject should not be disregarded, much less carped at. It has been suggested that some engineers could very desirably make tests occasionally as opportunity may arise. Some gas works are situated in close proximity to the local sewage works; and in these cases the opportunity for experiments is always more or less present, with a minimum of difficulty. As stated, the cost of destroying sewage matter in some towns is enormous. Many conflicting interests will, however, have to be overcome before the sanitary authorities will be prepared to pay to the local gas undertaking the amount, or any portion of it, it now costs them to destroy their sewage. The correct solution of the problem, as heretofore hinted at, would be for the sanitary authority to erect a retort bench, or preferably a small gas works, suitable for the special work. The money now spent in destructors, etc., would fully warrant such a step. By this means, all such tests could be kept independently from the gas works. The variability in the composition of sewage matter presents a real difficulty; but an experimental plant at a sewage works would provide means for ascertaining approximately the average quantity and quality of gas obtainable throughout an entire period.

The abolition of the moisture from the sewage sludge does not present an insuperable difficulty. Greater pressure brought to bear upon the material in its preliminary stages would accomplish much. If, instead of the material being pressed into cakes, it were made into briquettes in an efficient machine, these would be much better in every way for subsequent handling. The sludge, indeed, requires careful study and arrangement to adapt it to its changed manipulation and circumstances.

The large quantity of marsh gas, etc., present in sewage matter, certainly warrants an extensive and full inquiry. From the sanitary standpoint, the subject is full of importance. The complete destruction of the material alone favors the process. It is a fact that the question of sanitation is becoming an increasingly difficult problem in all large centers of population. Anything, therefore, which will aid in such a matter should unquestionably be gladly welcomed by sanitary authorities. Something further requires doing now. Mr. Harman and others have demonstrated the practicability of sewage sludge being carbonized under different conditions. Careful analyses of the composition of the material in various parts of the country should be attempted. This could be well dealt with by the medical officer of health, upon whom devolves the direct responsibility for the health of the community. Possibly such information is already in the hands of many of these gentlemen, including, as they do, some of the first scientists of the day. At the majority of sewage works, too, qualified chemists are engaged, who may well turn their attention to the subject. What in days gone by must have proved a sufficient obstacle to the handling of the material, is in these days of multiplied mechanical contrivances abolished with the greatest case.

The absence of tar is inconsequential for the moment, while that residual is at so low a price. The quantity of ammonia recoverable will compensate; sulphate of ammonia being likely to well maintain its price in future. The education of the farmer to its agricultural value is spreading, as the result of the energetic efforts of the Sulphate of Ammonia Committee, with Mr. W. G. Blagden as Chairman. A reduced quantity of coke output would also enhance the price of that placed upon the market, as, in a measure, carburetted water gas plants must already have done.

Electrical Fires and Spontaneous Ignition in Warehouses.

The *American Exchange and Review* reports that Dr. A. M. Read, Manager of the American Security and Trust Company's warehouse, in Washington, D. C., submitted, at a recent convention in St. Louis of the American Warehousemen's Association, a committee report on causes and prevention of fires in warehouses, which especially refers to the dangers from electricity and spontaneous ignition. On these subjects the report states that:

The greatest danger from electricity arises from bad workmanship and material used in the fabrication of the apparatus that is to carry this force through our buildings, and the equally bad methods used in its installation. This is due in part to the ignorance of the manufacturer and artisan, and in part to the dishonest endeavor on the part of some of them to overreach their rivals in trade. The faults of manufacture are being rapidly eliminated by the action of the National Fire Underwriters' Association, who are making extensive laboratory tests of material and certifying results to their constituent associations of the various cities for the use of their inspectors. The faults of construction are also much lessened by the inspections made under the authority of the underwriters' association. Still, these present precautions do not lessen the danger from systems of electric wiring put in from two to fifteen years ago, nor by any means eliminate the element of danger from wiring now being put in.

Fires are of frequent occurrence through the bursting of lamps, caused by the short circuiting of the wires in the socket or by the falling down of the carbon filament, when hot, against the glass when the lamps are laid on their sides, or by our own carelessness in laying the lamp on or hanging it against inflammable material while lighted. The blowing out of plugs and the melting of fuses in proximity to or over combustible material is an ever present danger, as is the short circuiting of the wires from a hundred and one reasons.

Fires also occur from defective transformers; from the overloading of wires; from the grounding of the current by the falling of wires across gas pipes, etc.; from the contact of wires of different potentialities; from the abrasion of flexible cord carrying portable lamps, either by the metal parts of the lamp socket or by projections, and from countless other causes connected with this only half known force.

The most interesting and probably the least dangerous, when well understood, cause for fires that the warehouseman has to deal with is that of spontaneous combustion. To the lay mind the phrase "spontaneous combustion" is used to cover all fires arising from remote causes, such as the leakage of acids upon organic matter, or on other chemicals, for which it has a strong affinity, and with which it will engender heat to the point of ignition; the explosion of gases; the action of water on quicklime, and the supposed affection of mice and other rodents for lucifer matches, etc. The leakage of strong acids on

to other chemicals, such as turpentine, chlorate of potassium, etc., or upon sawdust containing oils, etc., from other leakages, has caused, and will cause, fires. The danger, however, is not great, as the storage of such acids is of comparatively rare occurrence, and the very nature of the goods will put the warehouseman on notice to handle carefully and place away securely. The same may be said of explosive substances, the damage from which depends more upon the force than upon fire, which may or may not follow.

Drying oils, like linseed and poppyseed oils, appear to be more quickly acted upon by the air than non-drying oils, like olive oil, cottonseed oil and the animal oils and fats. This latter class appears to require time to become rancid before the air will act upon them energetically at ordinary temperatures. It has been shown, however, that all vegetable and animal oils will spontaneously inflame in a comparatively short time at temperatures only slightly above the ordinary summer heat. For instance, when exposed in a chamber to a temperature of 130° to 170° F., as follows:

Boiled linseed oil on cotton waste ignited in	....	1½	hours.
Raw linseed oil on waste	"	 4	"
Lard oil on cotton waste	"	 4	"
Colza oil on cotton waste	"	 6	"
Olive oil on cotton waste	"	 5	"
Sperm oil on cotton waste	"	 4	"
Castor oil on cotton waste	"	24	"

Your committee has given considerable space to the consideration of the two causes of fires, electricity and spontaneous combustion, because, in the case of former, while the nature of the danger is known, its great and coustant imminence is not fully appreciated, and because in the latter its nature is little known and its dangers are much exaggerated.

Your committee would suggest that all electric light and power wires be laid in rubber-lined iron pipe, and that all material used from wire to lamp and dynamo be of a kind tested and recommended by the National Association of Fire Underwriters of the United States, whose lists of electrical fittings can be obtained from your insurance agent. It would also suggest that the whole electrical system in your warehouse be rigidly inspected by your own engineer, if competent; if not, by some well known expert, at stated periods not longer than 6 months apart, and that all defects be promptly remedied. By these means and by constantly looking after lamps, flexible cords, etc., you will enjoy an immunity from a large portion of danger that electricity inevitably brings.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

MR. W. E. FINDLAY, Secretary of the Columbus (O.) Gas Light and Heating Company, has notified the shareholders that a dividend of 3 per cent. on the Company's preferred stock is payable the 1st prox.

MR. DANIEL P. ELMER, who for something over 30 years has served on the Board of Directors of the Bridgeton (N.J.) Gas Light Company, died the morning of the 19th inst. He was in his 85th year.

THE authorities of Bound Brook, N. J., have agreed to permit the owners of the Somerset Lighting Company, of Somerville, N. J., to supply gas within the limits of their jurisdiction. A leading feature of the ordinance is that the Company agrees to pay 2 per cent. of its gross receipts for the privilege. Secretary Knapp did most of the work in connection with the Company's application.

OCEAN CITY, which is on the southern coast of New Jersey, about half way of Atlantic City and Cape May, is to have a gas works. The movers in the matter are the proprietors of the Trenton (N. J.) Gas and Electric Company.

THE petition of the Worcester (Mass.) Gas Light Company to the State Board of Gas and Electric Light Commissioners, for the right to increase its capital in the sum of $200,000, has been favorably considered. It is stipulated that the maximum price shall not be less than $175 per share.

THE American Bridge Company is furnishing from its East Berlin (Conn.) plant the steel work for power station No. 3 for the Hartford (Conn.) Electric Light Company.

AT the annual meeting of the Rahway (N. J.) Gas Light Company the Directors elected were: Messrs. John Kean, James McGuire, Hamilton Kean, Francis Engel, Julian H. Kean, James Vanderhoven, A. F. Reitemeyer, Henry Simmons and F. A. Price.

ALL the details for the merging of the gas and electric lighting interests of Newburgh, N. Y., have been completed. The concern is to be known as the Newburgh Light, Heat and Power Company, and the capitalization of the concern will not be less than $1,000,000. This absorption and merging resulted largely through the manipulation of Mr. B. B. Odell, the Governor-elect of New York.

A CORRESPONDENT in Raleigh, N. C., forwards the following: "The proprietors of the Raleigh Gas Company have spent a very large sum on its plant, the work having been done under the direct supervision of Mr. S. E. Linton, whose satisfaction now is in the fact that the residents of this place will have a gas service that cannot fail to please the most exacting of them."

THIS is from a recent issue of the Portland (Ore.) *Telegram*: "Since the reduction of the price of gas on the 1st of last August, our customers have increased at a phenomenal rate, said an official of the Gas Company this morning. In summarizing the 1st of November a most astonishing number of new patrons were found to have been registered last month. Our force of employees has been greatly increased, yet there is a bustle and rush in getting out our daily orders for gas stoves, heaters, hot plates, fixtures, Welsbach lamps, burners, etc. Yes, our reduction in the price of gas was timely, because the public have shown an appreciation of it. They have responded, as we hoped they would. Gas before the reduction was an equal competitor of wood, and now is by far the cheaper. The reduction caused the people to make the comparison we have been endeavoring to get made for years. I mean the comparison by actual use. Nothing short of this cuts any figure in our business. Now the use of gas ranges, heaters, Welsbach burners, etc., will go swimmingly on because we have so many good references. Every day people come in here to tell us how well pleased they are at having begun the use of gas in cooking or lighting. I'll tell you, it's very encouraging to have delighted customers come in and tell us so."

THE American Bridge Company is furnishing from its Lafayette plant five bridges for Montgomery county, Ind.

THE Stacey Manufacturing Company, through its Eastern agents, Messrs. J. K. Dimmick & Company, has secured a contract from the Consolidated Schuylkill Gas Company, of Phœnixville, Pa., for a gasholder of 75,000 cubic feet.

MR. PRYCE W. BAILEY has resigned from the service of the Seneca Falls and Waterloo (N. Y.) Gas Company, the resignation to become effective December 1st. Mr. William Cady, of Port Huron, Mich.. has been appointed Superintendent to the Company.

SOME time ago we said that the Lawrence (Mass.) Gas Company was about ready to extend its pipes to and through the adjoining or nearby town of Andover, for we supposed that the Company's application to the Selectmen for the right was equal to favorable action. The filing of the petition, however, was later on followed by the filing of another on behalf of the projectors of the Andover Gas Company, and the Selectmen have in consequence named Monday, December 3d, as the day set for a hearing in public on account of both applications.

THE Andover *Townsman* of recent date, commenting on the situation, says: "The fact that a hearing is called for December 3d to consider two petitions for gas franchises in Andover is about all there is to be said about the gas business this week. Mr. Barnard contributes his side of the question in an interesting communication in another column, the burden of which seems to be a plea for support on local grounds. This is in fact the issue upon which the Selectmen are to be called to act, whether rights shall be granted to a well organized company already doing a successful business, but outside of the town limits, or to a local company, to be organized to do a business, the success of which time alone can determine. There seems to be no better suggestion to make to the public this week in connection with this latest problem than the suggestion to go slow and consider all sides before a committal to either side."

MR. W. C. SHELBURNE, of Salt Lake City, Utah, is informed that we put no credence whatever in the assertion that on and after January 1st the Merced Falls Gas and Electric Light Company, of Merced, Cal., will discontinue the supply of gas on illuminating account.

THE report is given as standing for positive fact that the plants and franchises of the Portsmouth (N. H.) Gas, Electric Light and Power Company have been disposed of to a syndicate, a prominent member of which is Mr. Wallace D. Lovell, of Boston.

AT the invitation of the *Merchants' Association Review*, of San Francisco, Mr. John T. Doyle, a prominent resident of San Francisco, prepared a lengthy statement respecting "Municipal Ownership and Management of Public Utilities in San Francisco." Regarding gas works in such connection Mr. Doyle wrote:

"The production of artificial light is a manufacturing business, wherein the producer makes use of the public streets (underground) for his own benefit and that of his customers; the latter are so numerous, and the city itself is an important one of them, that there is excellent reason why the use of the streets by a private company should be permitted, provided that the public and riparian property holders are protected against too frequent disturbance and imperfect restoration of the surface. In Dublin, whenever it is proposed to break up the pavement at any point, the party desiring to do so must first obtain a permit from the Board of Public Works and deposit with them the estimated expense of restoring it after the work is finished. On completion of the work, within the limits of the permit, the street surface is restored to good order by the Board of Public Works, who then return to the party interested any portion of his deposit left over after paying the cost. Thus the uniformity of surface and the character of workmanship and responsibility for it are preserved. I am glad to see that the same system has been adopted by the charter of San Francisco. Hitherto the course has been to sidewalk the street first; then to have it planked or cobblestoned or paved in some way; then ordered to be graded, after which came paving. All this usually preceded the laying of gas and water pipes, and after they had invited population the surface was again broken to put in a sewer. My knowledge of two gentlemen of the present Board of Works satisfies me that this sort of abuse will not be permitted by them, but the street contractor gang are compact, well organized and alert, and constant vigilance alone will prevent it. As to permitting the city officials to embark it in any business presenting such opportunities for stealing under the disguise of commissions, divisions of profits, etc., in the purchase of coal, lamp posts, pipes, electrical supplies, etc., and the employment of thousands of laborers, skilled and unskilled, as well as the sale of disused material and by-products, by the city, it appears to me little short of madness."

THE Chicago *Journal* of recent date says that to regulate the price of gas and to protect the consumers from gas corporations is the main object of Ald. Butler's proposed law now before the City Council for consideration. The measure, which was referred to the committee on State legislation, provides for the appointment by the governor of a commission of three Illinois citizens, to hold office for 6 years, at $5,000 a year, with a secretary at $4,000. The draft of the measure submitted by Ald. Butler is based upon a similar law in Massachusetts, which is said to work well. It provides that every gas company in the State issue an annual statement, explaining its financial condition, its income and expenses, its dividends, and the salaries its officials receive. It also provides for the regulation of prices of gas and electric light. It prohibits the transfer of franchises without the consent of the legislature, and it makes it impossible to water the stock. An investigation of the affairs of any gas concern in the State may be secured on the order of the mayor, the trustees, or 20 citizens of a town, and the officers of the company may be summoned to such investigation. The commission is empowered to lower the rate for gas or electric light when it is deemed fit to do so. The company on its own behalf is allowed to appeal to the commission for the redress of any grievance.

THE betterments on the plant of the Richmond (Va.) Municipal Gas Works are greatly appreciated by Superintendent Knowles and his men. That the contractors satisfactorily performed their part of the bargain would seem to be shown in the fact that the final payments on account of the work ordered have been made.

THE Baltimore *Sun*, of the 16th inst., said: "There is no longer any doubt that negotiations are in progress for an amalgamation of the Consolidated Gas Company and the United Electric Light and Power Company. The deal, it is understood, is being engineered by a syndicate of Eastern capitalists. The banking house of Messrs. Alexander Brown & Sons is interested. Mr. Brown is now in New York in connection with the deal, and will remain in the metropolis until Monday. Mr. Charles H. Dickey, Jr., who is mentioned in connection with the presidency of the combined properties in the event of the consummation of the deal, is also in New York, presumably on the same errand. Messrs. Brown and Dickey were accompanied to New York by Messrs. Frank Tilford and Henry R. Wilson, Directors of the Gas Company, who paid a hurried visit to Baltimore yesterday to attend a meeting of the Directors. This meeting was held yesterday afternoon, and *The News* learned to-day that an offer was considered. The basis of the deal is understood to be the lease of the Gas Company in perpetuity and the purchase from the United Railways and Electric Company of the $2,000,000 of common stock of the United Electric Light and Power Company. It is proposed to guarantee a scaling dividend on gas stock, beginning with 2½ per cent., and gradually increasing the rate as the business of the Company expands. The proposition further provides for an issue of $2,500,000 of 4½ per cent. certificates of indebtedness. Of the certificates of indebtedness $1,000,000 will, it is understood, be given to the United Railways and Electric Company in exchange for its holdings of United Electric Light and Power common stock. Certificates of indebtedness to the amount of $1,500,000 will be sold for the purpose of raising funds to improve the Gas Company's plant. It is also proposed to guarantee the dividend of 5 per cent. on the preferred stock of the United Electric Light and Power Company. There is also talk of issuing 3½ or 4 per cent. bonds to be exchanged for the stock of the Gas Company on the basis of 75. As a guarantee that the syndicate would fulfill the terms of the agreement, it has signified, it is understood, its willingness to deposit with a local trust company $2,000,000. It is understood that the Directors of the Gas Company have tacitly agreed to recommend to the stockholders the acceptance of the offer, provided that certain details connected with the transfer of the property are arranged. The identity of the members of the syndicate is carefully guarded, but it is understood that they are men of wealth and practical in the lighting business. If the new interests obtain possession of the properties they will inaugurate an aggressive policy and offer inducements to increase the consumption of fuel gas. The first step in this direction would be a return to the old method of manufacturing gas out of coal instead of out of oil and water, as at present. When the change from coal to oil and water was made several years ago the cost of production was greatly reduced, but in recent years the cost of oil has increased so rapidly that many companies in the United States have returned to the old method. It would not be necessary for the Gas Company to build plants for this purpose, as it owns two fully equipped. It is expected that final details of the deal will be arranged in New York."

Engineering News reports that two induction coils giving each a spark of 42 inches in length, representing about 400,000 volts, were exhibited by Queen & Company, at their rooms at 59 Fifth avenue, New York city, during a few days of last week. The coils have been ordered by the Japanese Government for use in experiments in wireless telegraphy, although the most successful work heretofore done in wireless telegraphy has been with spark lengths of only a few centimeters. The secondary of each of these coils contains about 125 miles of No. 32 copper wire wound in vertical layers, which are grouped in two large sections. The core consists of bundles of iron wire, weighing about 250 pounds. It projects about 15 inches beyond the secondary at either end, the best length having been determined by experimentally plotting the field of force. The primary winding takes 20 amperes at 25 volts. The make-and-break apparatus is mounted upon a separate stand, which contains also the adjustable condenser. The break is made in a bath of alcohol between platinum button shaped electrodes, the upper one of which is moved up and down by a cam movement driven by an electric motor. At the same time the lower button is slowly rotated. The frequency of the break may be varied from one to several thousand per second.

THE same authority also says that one of the largest chimneys in the State of New York, and probably in the country, has just been completed at the new power station of the Schenectady Locomotive Works by Contractor John McDermott, of Schenectady, N. Y., who is also the President of the Board of Water Commissioners of that city. The chimney is 200 feet in height, and is 32 feet square at its base. For nearly 40 feet it rises perpendicular, and then assumes an octagonal form and gradually batters to 16 feet in diameter at the top, where it flares and is surmounted by an iron cap 3 feet high. The flue is 10 feet in diameter. About 600,000 brick were used in constructing the chimney, which cost upwards of $16,000.

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MONDAY, NOVEMBER 26, 1900.

The Market for Gas Securities.

There was quite an exhibition of fireworks last week during the trading in local gas shares, with Consolidated securities furnishing most of the aerial flights. Last Friday the close in Consolidated was made at 192 to 192½, and before noon of the next day trades had been made at a fraction over 201. This skyrocketing was traceable to supposed action taken by the triumvirate the afternoon of the 16th inst., when some important determination in respect of "melonic" dividends was "considered." Since then the stock has sagged quite a bit, the closing to-day (23d inst.) having been made at 192½ to 193. There is no doubt that important matters were arranged last week at the meeting of the "three," and it is our belief that even at something over 200, investment holders will have no cause for complaint as to what is to come. Especially is this so in the instance of the fortunate ones who exchanged "common" stock in the amalgamated electric concerns for Consolidated on the exchange basis of $232 per share. City gas bonds are in good demand.

Brooklyn Union is not as "weak" as it was, and there cannot be any doubt that it is to be stronger. The general gas list is improving, with Peoples, of Chicago, and Consolidated, of Baltimore, offering excellent opportunities for investment. The value of Washington (D. C.) gas constantly appreciates. Hartford gas is offered at 250, with 240 bid for it.

Gas Stocks.

Quotations by George W. Close, Broker and Dealer in Gas Stocks.

16 WALL STREET, NEW YORK CITY.

NOVEMBER 26.

☞ All communications will receive particular attention.
☞ The following quotations are based on the par value of $100 per share.

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated	$54,595,200	100	192¼	193
Central Union, Bonds, 5's	3,000,000	1,000	106	107½
Equitable Bonds, 6's	1,000,000	1,000	105	..
" 1st Con. 5's	2,300,000	1,000	110	..
Metropolitan Bonds	658,000	..	108	112
Mutual	3,500,000	100	298	303
" Bonds	1,500,000	1,000	100	102
Municipal Bonds	750,000	..	..	..
New Amsterdam Gas Co. ..				
Bonds, 5's	11,000,000	1,000	108¼	109
Northern Union, Bonds, 5's.	1,250,000	1,000	104	104½
New York and East River ..				
Bonds 1st 5's	3,500,000	1,000	106	109½
" 1st Con. 5's	1,500,000	..	115	..
Richmond Co., S. I.	348,650	50	70	..
" Bonds	100,000	1,000	..	..
Standard	5,000,000	100	130	135
Preferred	5,000,000	100	150	158
Bonds, 1st Mortgage, 5's	1,500,000	1,000	115	114
Yonkers	299,600	500	130	..
Out-of-Town Companies.				
Brooklyn Union	15,000,000	100	175	180
" " Bonds (5's)	15 000,000	1,000	118	119
Bay State	50,000,000	50	1	1¼
" Income Bonds	2,000,000	1,000	..	75
Binghamton Gas Works	450,000	100	26	30
" 1st Mtg. 5's	475,000	1,000	96½	99½
Boston United Gas Co.—				
1st Series S. F. Trust	7,000,000	1,000	82	85
2d " " "	3,000,000	1,000	47½	50
Buffalo City Gas Co.	5,500,000	100	7	9
" " Bonds, 5's	5,250,000	1,000	68	71
Capital, Sacramento	500,000	50	..	35
Bonds (6's)	150,000	1,000	..	..
Central San Francisco	2,000,000	..	106	108
Chicago Gas Co. Guaranteed Gold Bonds	7,650,000	1,000	104	104¼
Cincinnati G. & C. Co.	8,500,000	100	191	193
Columbus (O.) Gas Co., 1st Mortgage Bonds	1,207,000	1,000	106	107
Columbus (O.) Gas Lt. & Heating Co	1,882,720	100	60	65
Preferred	3,096,500	100	84	86
Consumers, Jersey City Bonds	600,000	1,000	102	105
Consumers, Toronto	1,700,000	50	215	216
Consolidated, Baltimore	11,000,000	100	57¾	58¾
Mortgage, 6's	3,600,000	..	..	118
Chesapeake, 1st 6's	1,000,000	..	..	..
Equitable, 1st 6's	910,000	..	..	..
Consolidated, 1st 5's	1,490 000	..	..	112
Consolidated Gas Co. of N.J.	1,000,000	100	12	16
" Con. Mtg. 5's	880,000	1,000	80	85
Consolidated G. & E. Co.'s, Little Falls, N.Y.	90,000	100	..	100
Bonds	75,000	..	..	100
Detroit City Gas Co	4,560,000	50	95	97
" Prior Lien 5's	4,598,000	1,000	99¼	100
Detroit Gas Co., 5's	898,000	1,000	100	101
" Inc. 5's	16,000	100	94	94½
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	..	101
Essex and Hudson Gas Co.	6,500,000	..	35	40
Fort Wayne	2,000,000	..	35	41
" Bonds	2,000,000	..	60	64
Grand Rapids Gas Lt. Co..	1,000,000	50	105	107
" 1st Mtg. 5's	1,125,000	1,000	..	..
Hartford	750,000	25	240	250
Hudson County Gas Co., of New Jersey	10,500,000	..	25	..
" Bonds, 5's	10,500,000	..	101	103
Indianapolis	2,000,000	..	72	82
" Bonds, 6's	2 650,000	..	98	100
Jackson Gas Co	250,000	50	70	75
" 1st Mtg. 5's	250,000	1,000	101	102½
Kansas City Gas Light Co., of Missouri	5,000,000	100	..	36
Bonds, 1st 5's	3,822,000	1,000	101½	103
Laclede, St. Louis	7,500,000	100	72	72½
Preferred	2,500,000	100	96	100
Bonds	10,000,000	1,000	107	107½
Lafayette Gas Co., Ind.	1,000,000	100	35	40
Bonds	1,000,000	1,000	60	65
Louisville	2,570,000	50	110	120
Madison Gas & Elec. Co.	400,000	100	68	75
" 1st Mtg. 6's	350,000	1,000	102½	108
Montreal, Canada	2,000,000	100	182	184½
Newark, N. J., Con. Gas Co	5,000,000	..	..	55
Bonds, 6's	4,600,000	..	..	103
New Haven	1,000,000	25	280	300
Nashville Gas Lt. Co.	1,000,000	50	110	..
Oakland, Cal.	2,000,000	..	46	47
" Bonds	750,000	..	..	..
Peoples G. L. & Coke Co., of Chicago	25,000,000	100	98½	99
Peoples Gas Lt. & Coke Co., Chicago, 1st Mortgage	20,100,000	1,000	90½	91
2d "	2,500,000	1,000	104	105
Rochester Gas & Elec. Co..	2,150,000	50	68	..
Preferred	2,150,000	50	118	..
Consolidated 5's	2,000,000	..	87½	90
San Francisco, Cal.	10,000,000	100	47¼	47½
St. Paul Gas Light Co.	1,500,000	100	47	05
1st Mortgage 6's	650,000	1,000	82	85
Extension, 6's	600,000	1,000	..	..
General Mortgage, 5's	2,423,000	1,000	88	90½
St. Joseph Gas Co.	1,000,000	100	80	85
" 1st Mtg. 5's	750,000	1,000	96½	98
Syracuse, N. Y.	1,750,000	100	9	10
Bonds	1,612 000	1,000	88½	93
Washington, D. C	2,600,000	20	273½	275½
First mortgage 6's	600,000	..	..	..
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DIVIDEND NOTICE.

OFFICE OF THE AMERICAN GAS COMPANY,
222 S. THIRD ST., Phila., Pa., Nov. 21, 1900.

The Board of Directors of The American Gas Company have this day declared a semi-annual dividend of 3 per cent., or $3 per share, on the Capital Stock of the Company, payable on and after Dec. 1, 1900.

1329-1 R. L. BABCOCK, Secretary.

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A MAN

Of energy and experience to organize and take charge of the

GAS STOVE

Business for a large manufacturing corporation. Only a man of experience in the business will be considered.

Address "GAS STOVES,"

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I have been Empowered to Purchase

Good, usable, second-hand apparatus for a 10-inch or 12-inch works. Parties having for sale

Six to 8-Foot Meter, 10 to 16-Foot Purifiers and Suitable Exhauster,

Are invited to communicate with me at once, giving lowest price, dimensions and full description, conditions, etc.

ALSO WANTED,

Like parts for 6-inch works, to handle up to 75,000 or 100,000 cubic feet daily.

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Each 11 feet 6 inches high, 3 feet in diameter, inside measurement, and 6-inch connections—all connections reinforced. Two manholes to scrubber, with two sets of trays; also one 6-inch center valve. These have never been used.

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A Small Gas and Electric Light Plant,

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We will **save** you nearly **30 per cent.** on your **Steatite** or **Lava Gas Tips.**

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Unique in design and made on scientific principles. The flame, from specially designed Bunsen burner, plays up against a plate, forcing heat current down and out. Air currents superheated before reaching burner, assisting combustion and destroying injurious products by intense heat.

Fitted with special atmospheric burners, requiring no flue connections. Saves 50 per cent. in fuel. Uses natural or artificial gas. Utensil holder at top.

MADE IN TWO SIZES.

FINISHED IN BERLIN BLACK, ALUMINUM and ANTIQUE COPPER.

FULL LINE OF GAS APPLIANCES.

Manufactured by

William M. Crane Company,

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We have our own Pattern Shop, Foundry and Factory.

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SPECIAL ATTACHMENT GAS TAPPING MACHINE.

By the use of this attachment to our regular pattern machine your service men are exempt from danger of asphyxia, can make more taps a day, and need less help.

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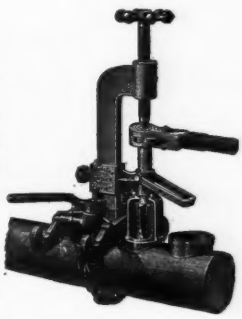

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—FOR—

Drilling and Tapping Pipe under Pressure

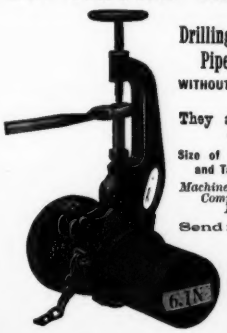
WITHOUT ANY ESCAPE OF GAS.

They are Strong and Compact.

Size of Combination Drills and Taps ¾ to 4-inch.

Machines Sent to any Gas Company for Thirty Days' Trial.

Send for Circulars.



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HIGH PRESSURE.

The Pioneer Vertical Water-Tube Boiler of the World.

Over 11½ Square Feet of Heating Surface per Horse Power.

High Quality and Durability of the Tubes the Most Vital Part of a Boiler.

Fastened at One End Only, Expand and Contract Without Strain, Averting any Possibility of Leakage.

Boilers we Built have been in Constant Use 18 Years, and are in Operation To-day with Fine Results.

10 to 25 Per Cent. Guaranteed Over Other Boilers.

Strong, Natural, Upright Draft, Consuming All Kinds of Fuel. Absolutely Dry Steam.

Small Floor Space, Less per Horse Power than for Any Other Boiler.

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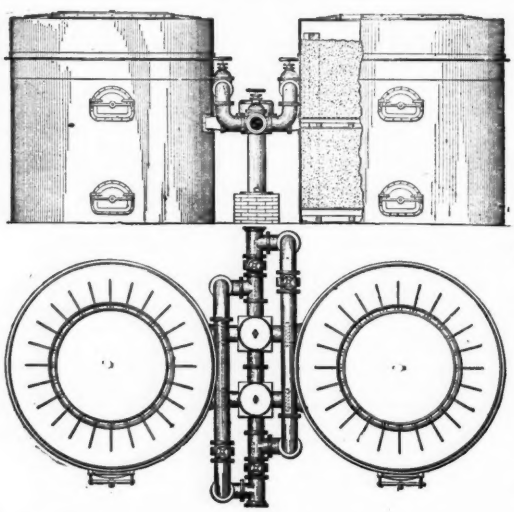

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The boxes are charged or discharged from the sides as well as the top.

There are no Hydraulic Cups or heavy covers.

Either end of the apparatus is inlet or outlet at pleasure.

The capacity is increased five-fold or more over ordinary methods without addition to building.

The apparatus costs less than for any other system.

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Winnipeg, Man.	500,000
Colchester, England (Second Contract)	300,000
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Gas, Electric Light, Water Works, and Electric Street Railways Built, Remodeled, Operated, Bought and Sold.

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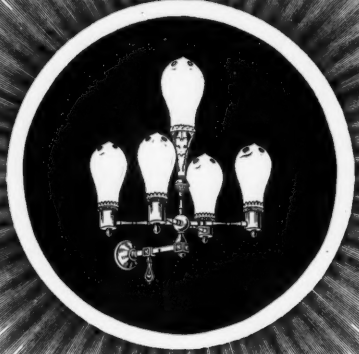

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SAVES 80 PER CENT. OF YOUR GAS BILL.

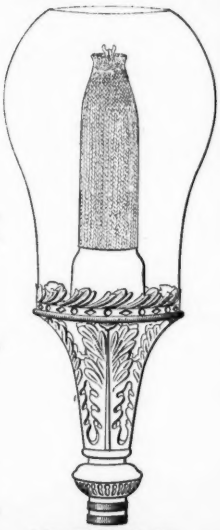
THE NEW DISCOVERY.
BURNS ONE CUBIC FOOT OF GAS PER HOUR.

No Chimneys to Break. Mantles do not Blacken. Better than Electricity, and only 1-10th the Cost. Not a mere statement, but a Guarantee.

CAN BE USED WITH { MANUFACTURED GAS. NON-CARBURETTED GAS. NATURAL GAS OR GASOLINE GAS.

35 TO 40 CANDLES PER CUBIC FOOT.

Burner No.	0	consumes	8-10	cubic foot,	30-candle	power.
"	1	"	1	"	35	"
"	2	"	2	cubic feet,	70	"
"	3	"	3	"	105	"
"	4	"	4	"	140	"
"	7	"	7	"	225	"



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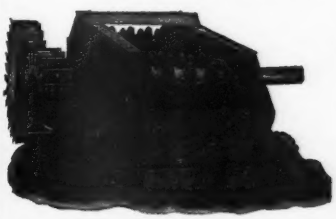
For all kinds of gas, including acetylene.
No mercury or glycerine used.
The most simple, inexpensive and effective governor on the market.
Made in three sizes.
List Price, ¾-inch, $4.50; 1¼-inch, $5.50; 2-inch, $8.
Should be attached by Gas Companies to insure correct work and best results.
Every Controller guaranteed absolutely. Discount to the trade.
FOUNDRY: PEEKSKILL, N. Y.
WILLIAM M. CRANE COMPANY,
1131 AND 1133 BROADWAY, NEW YORK.

SAFETY GAS MAIN STOPPER CO.
108 EAST 117TH ST., N. Y.

FOR SHUTTING OFF GAS IN MAINS TEMPORARILY DURING ALTERATIONS AND REPAIRS

THE LINK-BELT MACHINERY CO.,
ENGINEERS, FOUNDERS, MACHINISTS,
Chicago, U. S. A.



"Link-Belt" Breaker.

LINK-BELT ELEVATING & CONVEYING MACHINERY for HANDLING COAL, COKE, OXIDE, ETC.
Tilting Coal and Coke Cars,
Breaker Rolls, Shaking Screens,
Power Transmitting Machinery.
Machinery designed and erected to suit existing conditions and available space.
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AMERICAN GAS COMPANY

Constructors of Coal Gas Apparatus.

EASTERN AGENTS FOR

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Exhausters, Governors, etc.

GENERAL AGENTS FOR

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AMERICAN GAS COMPANY,

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Coal and Water Gas Plants.

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RECUPERATIVE FURNACES, WASHERS, CONDENSERS, PURIFIERS, PURIFYING MACHINES, COKE CONVEYERS, ETC.

SOLE UNITED STATES AGENT FOR
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Gas Enriching Plants to Enrich Coal Gas up to 24 Candle Power, and Making a White, Bright, Non-smoking Gas.

GAS RETORTS AND SPECIAL BLOCKS AND FIREBRICK MANUFACTURED UNDER THE SUPERINTENDENCE OF MY OWN CHEMIST.

COMPLETE GAS WORKS

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LATEST IMPROVED GAS EXHAUSTER

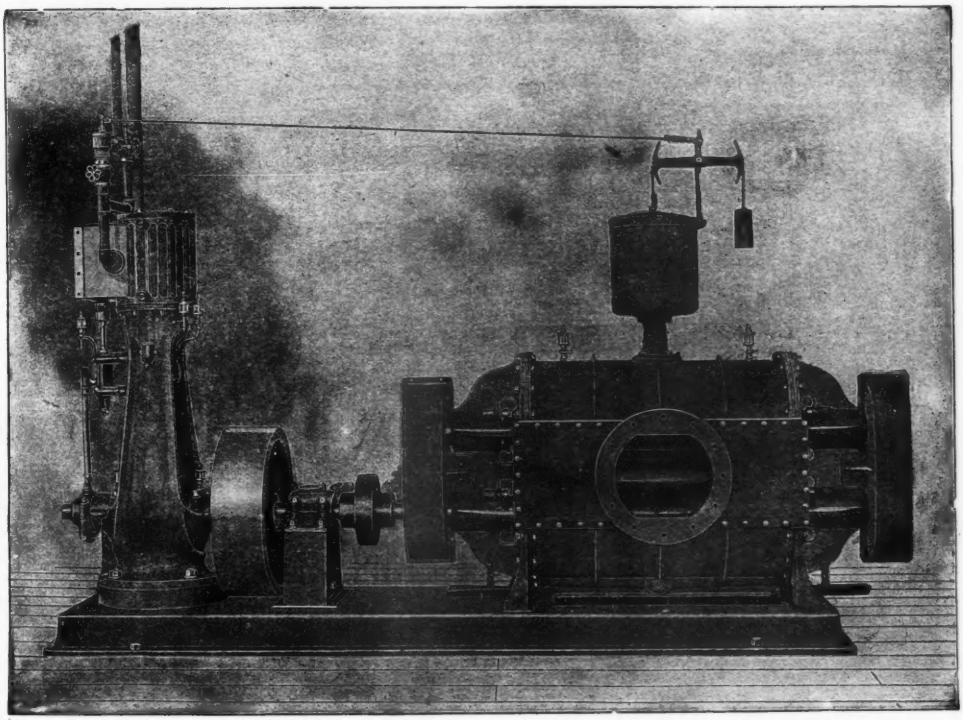
—AND—

NEW GAS GOVERNOR AND STEAM VALVE.

GUARANTEED TO REGULATE WITHIN ONE-TENTH OF AN INCH, WATER PRESSURE.

The Most Perfect Gas Governor on the Market.

MORE DIRECT IN ACTION. FEWER PARTS.
EASIER TO ADJUST THAN ANY OTHER GOVERNOR.



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Established 1856. Works at Phillipsburgh, N. J.

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CAST IRON WATER AND GAS PIPE,

From Three to Forty-Eight Inches Diameter. Also, all Sizes of

Flange Pipe for Sugar House and Mine Work. Branches, Bends, Retorts, etc., etc.

"Rose" Specials, Valves, Etc. M. J. DRUMMOND & CO. "Llanhorgan" Fire Hydrants

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To Retain Fluid Material of Any Sort.

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Work Done for Several of the Largest Gas Companies in America Stands as Reference.

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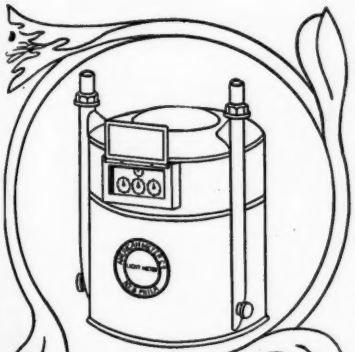
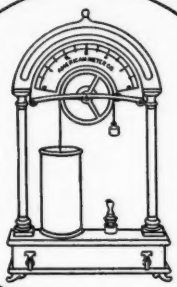
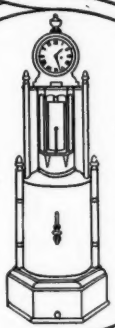
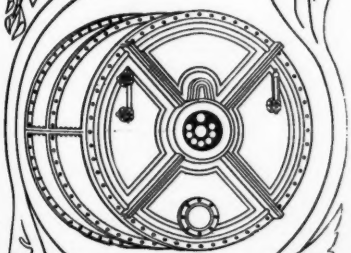








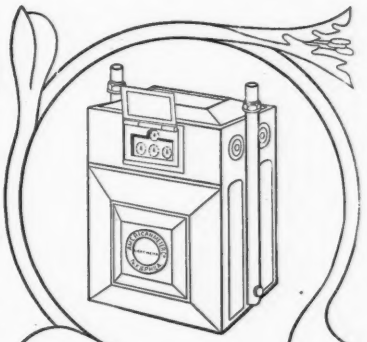
PUBLIC LIGHTING TABLE.

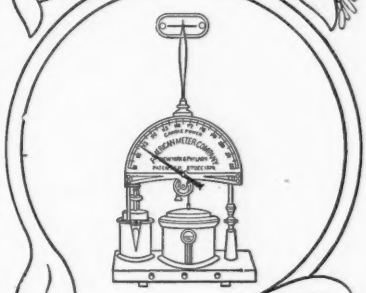
DECEMBER, 1900.

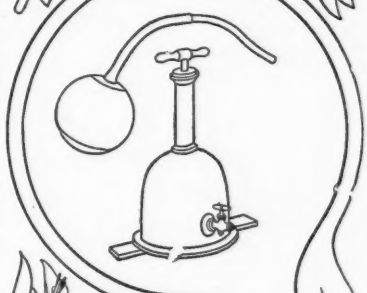
Day of Week.	Date.	Table No. 1. Following the Moon. Light.	Table No. 1. Following the Moon. Extinguish.	Table No. 2. New York City. All Night Lighting. Light.	Table No. 2. New York City. All Night Lighting. Extinguish.
				P.M.	A.M.
Sat.	1	1.30 AM	6.00 AM	4.20	6.10
Sun.	2	2.40	6.10	4.20	6.10
Mon.	3	4.00	6.10	4.20	6.15
Tue.	4	No L.	No L.	4.20	6.15
Wed.	5	No L. FM	No L.	4.20	6.15
Thu.	6	No L.	No L.	4.20	6.15
Fri.	7	5.00 PM	7.00 PM	4.20	6.15
Sat.	8	5.00	8.10	4.20	6.15
Sun.	9	5.00	9.10	4.20	6.15
Mon.	10	5.00	10.10	4.20	6.20
Tue.	11	5.00	11.10	4.20	6.20
Wed.	12	5.00	12.10 AM	4.20	6.20
Thu.	13	5.00 LQ	1.10	4.20	6.20
Fri.	14	5.00	2.10	4.20	6.20
Sat.	15	5.00	3.00	4.20	6.20
Sun.	16	5.10	4.00	4.20	6.20
Mon.	17	5.10	5.00	4.20	6.20
Tue.	18	5.10	6.20	4.20	6.20
Wed.	19	5.10	6.20	4.20	6.20
Thu.	20	5.10	6.20	4.20	6.20
Fri.	21	5.10 NM	6.20	4.20	6.20
Sat.	22	5.10	6.20	4.20	6.20
Sun.	23	5.10	6.20	4.20	6.20
Mon.	24	5.10	6.20	4.20	6.25
Tue.	25	5.10	6.20	4.20	6.25
Wed.	26	9.00	6.20	4.20	6.25
Thu.	27	10.10	6.20	4.20	6.25
Fri.	28	11.20 FQ	6.20	4.20	6.25
Sat.	29	12.30 AM	6.20	4.20	6.25
Sun.	30	1.40	6.20	4.20	6.25
Mon.	31	2.50	6.20	4.20	6.25

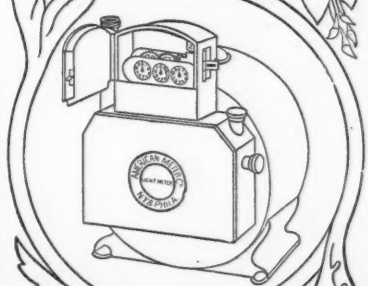
TOTAL HOURS LIGHTING DURING 1900.

By Table No. 1.	Hrs. Min.	By Table No. 2.	Hrs. Min.
January	230.50	January	423.20
February	175.40	February	355.25
March	189.00	March	355.35
April	160.30	April	298.50
May	150.40	May	264.50
June	137.00	June	234.25
July	152 00	July	243.15
August	171.50	August	280.25
September	187.20	September	321.15
October	213.10	October	374 30
November	221.50	November	401.40
December	231.50	December	433.45
Total, yr.	2221.40	Total, yr.	3987.45





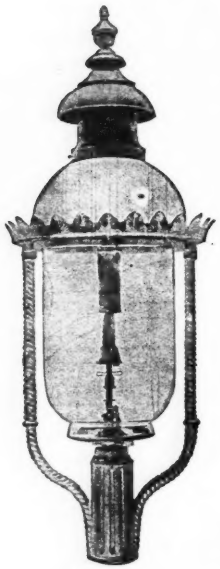




NEW YORK, 33 Nassau St. PHILADELPHIA, Broad and Arch Sts. CHICAGO, 54 Lake St.

Welsbach Street Lighting Company

.... OF AMERICA ....



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Controls and Operates the

Welsbach System of Street Lighting,

Which includes its specially DESIGNED AND PATENTED BURNER for STREET and PARK LIGHTING exclusively.

Uniformly SUCCESSFUL in seventy-five Cities and Towns.

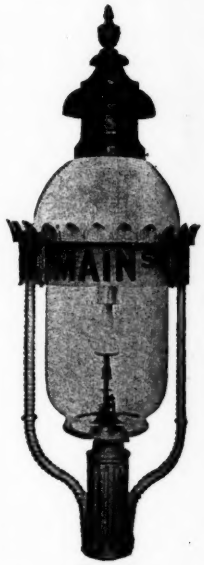
By means of the Welsbach System of street lighting the superiority of GAS over electricity for street lighting has been fully demonstrated.

POINTS OF MERIT:

It is { Economical, Attractive, Successful, Up-to-date.

IT LIGHTS THE STREET.

Where there are no gas mains we can furnish an equally good light by our SELF-GENERATING NAPHTHA WELSBACH BURNER, and thereby supply a uniform light in all localities.



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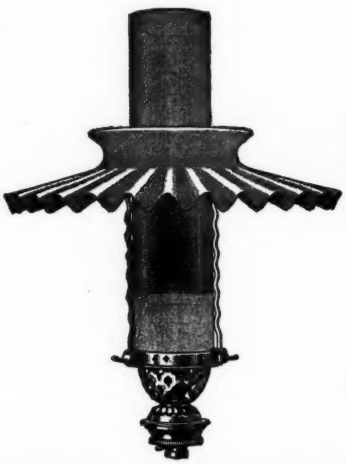
Welsbach Famous Mantles.

THE INCOMPARABLE

"Yusea" Welsbach Mantle

FINEST EXAMPLE OF INCANDESCENT GAS LIGHT EVER EXHIBITED.



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THE UNITED GAS IMPROVEMENT COMPANY.

THE STANDARD DOUBLE SUPERHEATER LOWE WATER GAS APPARATUS.

CONTRACTS RECEIVED SINCE JANUARY 1, 1900.

	SETS.		SETS.
DANSVILLE, N. Y.	1	HACKENSACK, N. J.	1
WEST CHESTER, PA.	1	TIFFIN, O.	1
COHOES, N. Y.	2	MOUNT HOLLY, N. J.	1
OGDEN GAS CO., CHICAGO	1	SEATTLE, WASH.	1
CENTRAL UNION GAS CO., NEW YORK	1	TARRYTOWN, N. Y.	1
SPENCER, MASS.	1	HOBOKEN, N. J.	2
SAN FRANCISCO	1	PATERSON, N. J.	2
BROOKLYN UNION GAS CO., BROOKLYN	1	NEWARK, N. J.	2
RICHMOND, VA.	2	JERSEY CITY, N. J.	1
CAMBRIDGE, MASS.	2	AUSTIN, TEX.	1
CARBONDALE, PA.	1	ELIZABETH, N. J.	1

NUMBER OF SETS 28
TOTAL SETS INSTALLED TO JANUARY 1, 1900 327
TOTAL SETS INSTALLED TO DATE 355
TOTAL DAILY CAPACITY . . . . . 227,000,000 Cubic Feet.

The United Gas Improvement Company,

Broad and Arch Streets, Philadelphia.

Established 1858. Incorporated 1890.
CHAS. E. GREGORY Prest. DAVID R. DALY V. Prest. & Treas.
H. D. ABERNETHY, Sec.

J. H. Gautier & Co.

Greene & Essex Streets,
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CLAY GAS RETORTS, FIRE CLAY TILES,
FIRE BRICK and FIRE CLAY SPECIALTIES

Ground Fire Clay, Fire Sand and Ground Fire Brick in Barrels and Bulk.

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Established 1854. Incorporated 1869.

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Fire Brick Manufg. Co.,

Manufacturers of { GAS RETORTS . .
FIRE BRICK . . .
RETORT SETTINGS

Water Gas Cupola Linings, Fire Clay, Etc.

Proprietors for the U. S., Coze System of Inclined Benches.

Estimates Furnished on Application for Most Successful Style of Construction.

Also for Free-Firing and Full and Half-Depth Regenerative Benches, for Burning either Coal or Coke in the Furnaces.

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The Construction of Gas Works

PRACTICALLY DESCRIBED,

By WALTER RALPH HERRING.

Price $2. For Sale by

A. M. CALLENDER & CO.,

32 Pine Street, N. Y. City.

Adam Weber,

Proprietor,

Manhattan Fire Brick and Enameled Clay Retort Works.

Works, Weber, N. J.

Office, 633 East 15th St., New York.

Modern Recuperative Furnaces

And Standard Fire Brick and Gas Retorts.

Works,
LOCKPORT STATION, PA.

—ESTABLISHED 1864.—

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PITTSBURGH, PA. P. O. Box 373.

Successor to WILLIAM GARDNER & SON,

Fire Clay Goods for Gas Works.

SOLE REPRESENTATIVE OF THE McILHENNY REGENERATIVE BENCHES FOR THE U. S.

HENRY MAURER & SON,

(ESTABLISHED 1856.)

EXCELSIOR FIRE BRICK & CLAY

RETORT WORKS

WORKS, Perth Amboy, N. J.

OFFICE, 418 to 422 East 23d St., N. Y.

Clay Gas Retorts,

BENCH SETTINGS,

Fire Brick, Tiles, Etc.

GEROULD'S IMPROVED RETORT CEMENT

A Cement of great value for patching retorts, putting on mouthpieces, making up all bench-work joints, lining blast furnaces and cupolas. This cement is mixed ready for use. Economic and thorough in its work. Fully warranted to stick.

Price List, f.o.b. Galesburg, Ills., or Buffalo, N. Y.
In Casks, 400 to 800 pounds, at 5 cents per pound.
In Kegs, 100 to 200 " " 6 " "
In Kegs less than 100 " " 7 " "

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For orders East of Buffalo, N. Y., or Pittsburg, Pa., freight will be paid to these points.

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CITY OFFICE,
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OAKHILL GAS RETORT & FIRE BRICK W'KS

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Materials for Gas Companies

We have studied and perfected three important points. Our retorts are made to stand changes of temperature, the strongest heats of the furnace, and the abrasion of feeding and emptying. We construct

Half and Full Depth Benches of Our Own Design,

Containing 6, 8 or 9 Retorts.

We have Greatly Improved our Recuperators. Coal or Coke can be used as Fuel in Furnaces.

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MANUFACTORY AT

LOCUST POINT, BALTIMORE, MD.

Clay Retorts, Blocks & Tiles

FIRE BRICK, FIRE CLAY, AND FIRE CEMENT.

Our Improved Half and Full Depth Benches have been Adopted by Many Gas Companies.

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Sole Agents for New England States.

JOHN DELL,
General Manager.

MISSOURI FIRE BRICK CO.,

ESTABLISHED 1882.

— MANUFACTURERS OF —

Gas Retorts, Bench Settings, Fire Brick, Cupola Linings, Etc.

We are prepared to furnish and erect COMPLETE, Half and Full Depth Benches of 6's, 8's, 9's, with Regenerative Furnaces, Constructed to Burn either Coal or Coke. Also Plain Benches.

CORRESPONDENCE IS RESPECTFULLY SOLICITED.

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SOFT COAL OR COKE
WATER GAS GENERATORS
A SPECIALTY.

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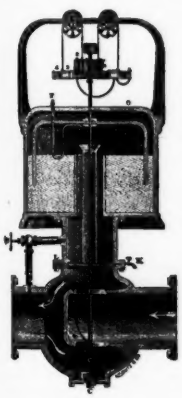
Gas Engineers
INSPECTION AND ADVICE.

PLANS AND ESTIMATES
FOR IMPROVEMENTS OR
REPAIRS.

GAS WORKS SPECIALTIES,



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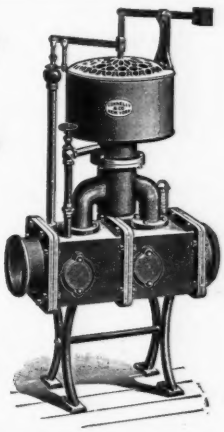
BALANCE GAS GOVERNORS.
"Iron Sponge" and Natural Oxide
FOR GAS PURIFICATION.
EXHAUSTERS, ETC.



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No. 357 CANAL STREET,
NEW YORK CITY.

WESTERN BRANCH CONNELLY IRON SPONGE & GOVERNOR CO.,
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Hughes'
"Gas Works,"

Their Construction and Arrangement,

And the Manufacture and Distribution of Coal Gas.

Originally written by SAM'L HUGHES, C.E.

Rewritten and Much Enlarged by
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Eighth Edition, Revised, with Notices of Recent Improvements.

Price, $1.65.

A. M. CALLENDER & CO.,
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Parson's Steam Blower

FOR IMPROVING BAD DRAUGHT IN BOILERS, AND FOR BURNING BREEZE OR OTHER WASTE MATERIAL.

PARSON'S TAR BURNER.

FOR USING COAL TAR AS FUEL.

PARSON'S AIR JET TUBE CLEANER.

FOR CLEANING BOILER TUBES.

These devices are all first-class. They will be sent to any responsible party *for trial*. No sale unless satisfactory. Manufactured by the WATERTOWN STEAM BLOWER COMPANY.

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The Gas Engineer's Laboratory Handbook,

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Practical Hints on the Construction and Working of Regenerator Furnaces,

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SHIPMENTS FROM NEW YORK, PHILADELPHIA, BALTIMORE AND NORFOLK.

BERWIND-WHITE COAL MINING COMPANY'S

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STRICTLY High Grade. . . . .
Carefully prepared.
For Gas Making or
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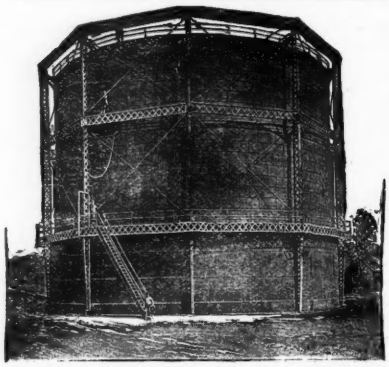

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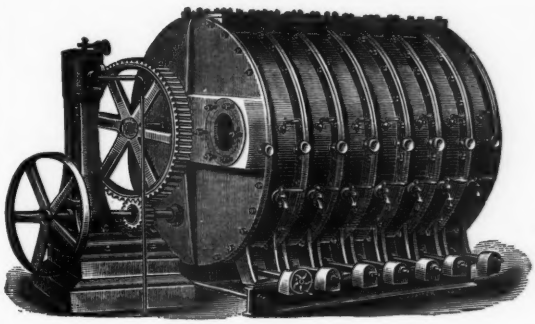

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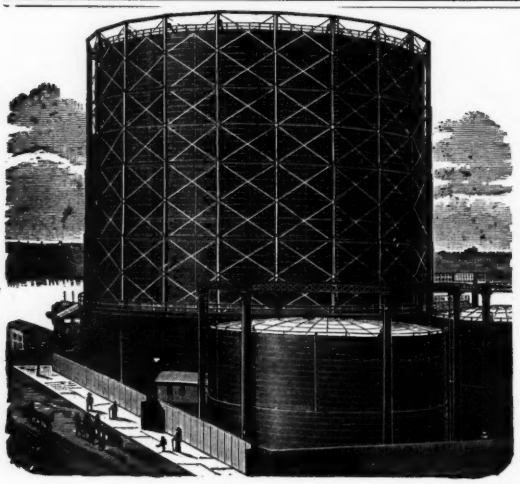

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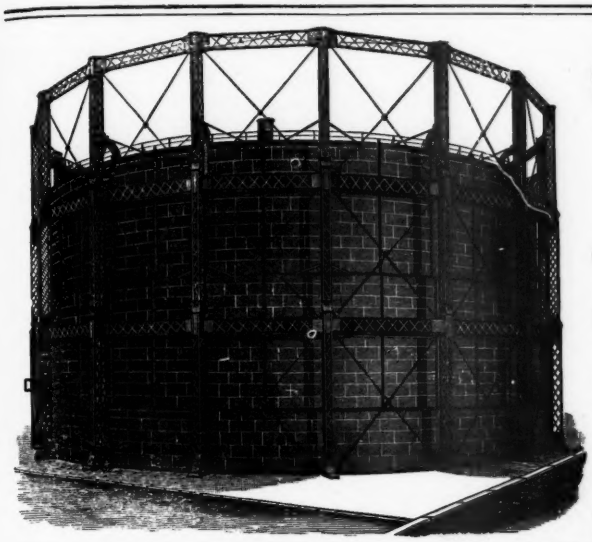

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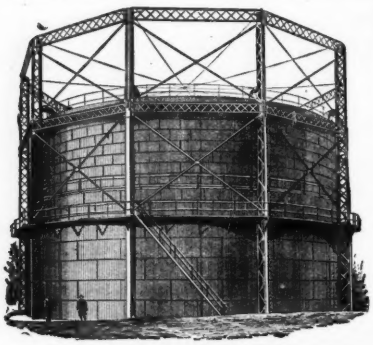

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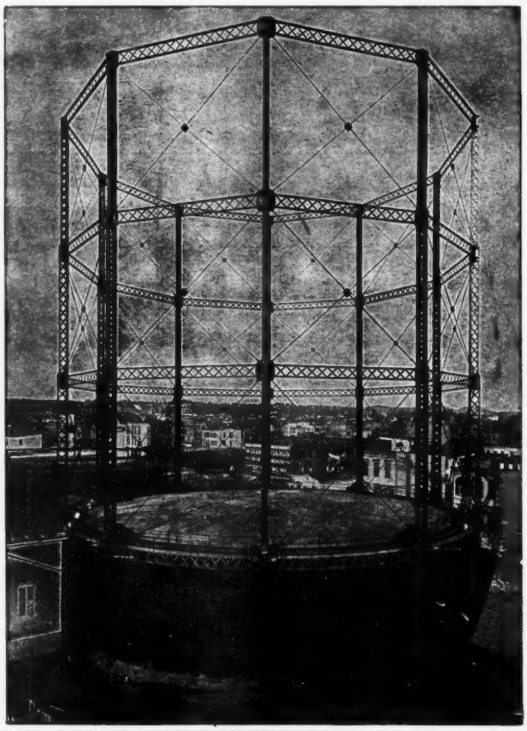

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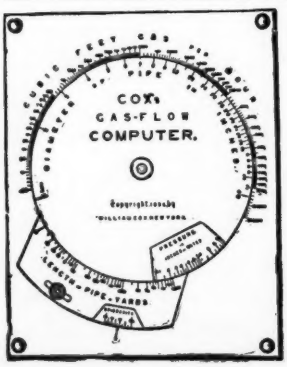

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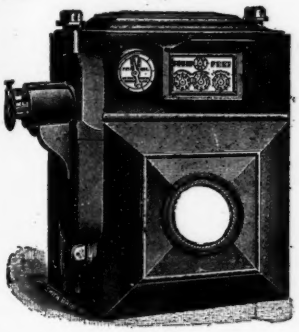

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